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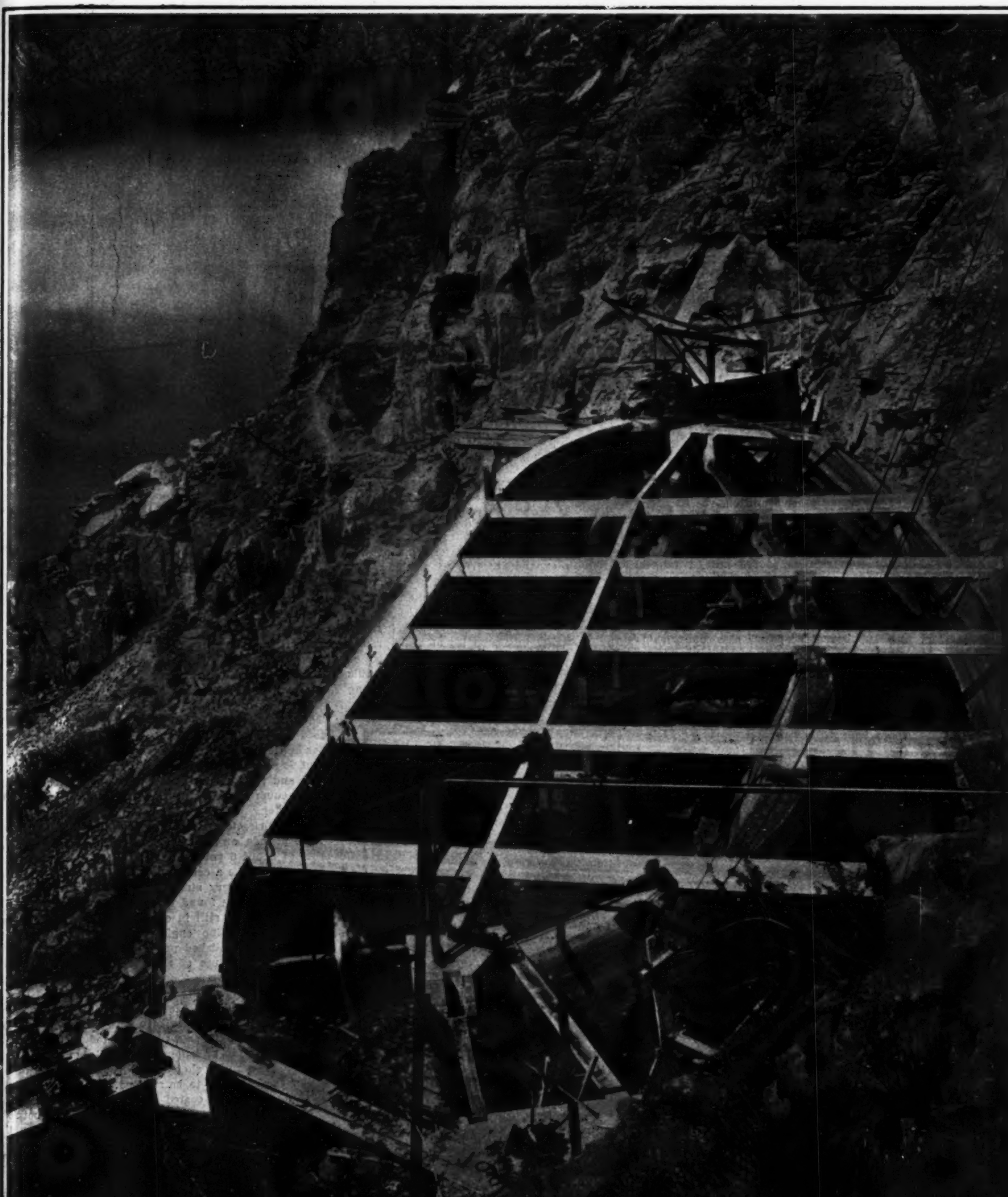


VIEW OF SETTLING BASIN AT THE END OF POWER CANAL.

THE ROOSEVELT DAM.

THE ROOSEVELT DAM.

WATER AND POWER DEVELOPMENT AT SALT RIVER, ARIZONA.

BY EDMUND G. KINYON.

THE government dam across the Salt River at Roosevelt, Arizona, is nearing completion after about six years of active building. The cap stones have been placed in position on the first 60-foot section of the structure, and it is expected that the entire masonry work will be finished during the present year.

Taking the south end of the dam as the initial point, the following heights have been attained: The first 60 feet is 228 feet in height; the next 30 [illegible] 238½ feet; the next 100 feet, 228 feet; the next [illegible]t, 212 feet; the next 100 feet, 200 feet; the next 85 feet, 192 feet; the next 60 feet, 180 feet; the next 150 feet, 190 feet.

The total length thus aggregates 645 feet; but these figures will be increased somewhat when the entire length of masonry is brought up to a level.

The dam is already in practical use and nearly 200,000 acre feet of water is stored behind the massive base awaiting its mission in the fields far below. Measured at the dam, the depth of water is about 120 feet. As the lowest unfinished section is 180 feet in height, there still remains 60 feet of resisting dam available. At the 180-foot level the amount of water stored would be 524,624 acre feet. The completed reservoir will be 2½ miles wide by 25 miles in length.

Three methods are provided for drawing the water off as it is needed:

Through a power canal, 18 miles in length, having an elevation of 240 feet above the level of the river at the crest of the dam where it enters a penstock that runs to the power house below the dam and about 21 feet above the level of the river.

Through a 10-foot diameter pipe penetrating the dam, starting at its up-stream face about 75 feet above river level and terminating at the power house.

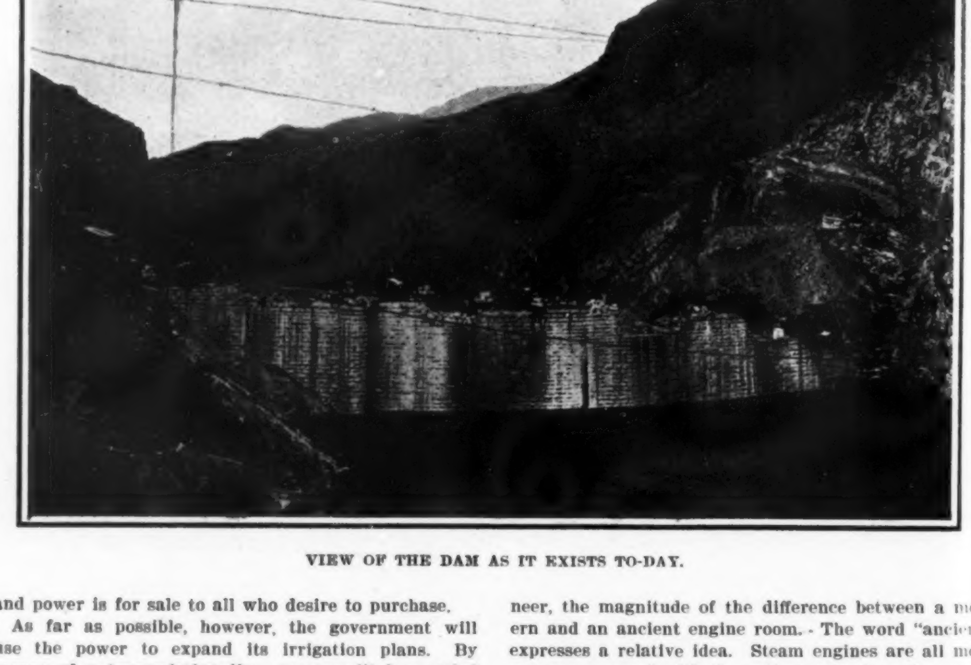
Through the sluicing tunnel, 12 by 9 feet, that leads, at the level of the river, through the mountain side to the river below the dam.

Any or all of these methods may be employed as the height of the stored water and other conditions require.

The area of land to be irrigated by means of the reservoir is about 210,000 acres, lying in the valleys of the Salt and Gila Rivers, from 60 to 200 miles below. Of this about 190,000 acres may be reached by gravity, leaving 20,000 acres to be served by pumps driven by electric power generated by means of the flowing water.

The plan to secure a supplementary power service from the dam is now being put into practice. In all, it is calculated that 25,000 horse-power can be developed. Starting at the dam, for a distance of 60 miles the water is being harnessed no less than eight times, wholly or in part, each time developing energy ranging from 7,500 to 700 horse-power. All of the power developed at the various stations is brought together by cables and carried through the mountains and valleys by a system of transmission cables. The city of Phoenix is already using 2,000 horse-power, and power is for sale to all who desire to purchase.

As far as possible, however, the government will use the power to expand its irrigation plans. By means of a transmission line, power will be carried a distance of 100 miles to the Sacaton Indian Agency, there to pump water for the irrigation of 10,000 acres of land to be cultivated by the Indians. Wherever, within a radius of 200 miles, bodies of underground water can be found adjacent to suitable land, the power will be conveyed and harnessed to pumps. In this way the benefits of the great engineering undertaking will be extended from one-third to one-fourth over the original expectations.



VIEW OF THE DAM AS IT EXISTS TO-DAY.

VIEW OF POWER CANAL AND GOVERNMENT CEMENT MILL.

THE ROOSEVELT DAM.

ENGINE ROOMS—ANCIENT AND MODERN.

THE men of the present generation who go down to the sea in ships cannot possibly realize, says the Engineer, the magnitude of the difference between a modern and an ancient engine room. The word "ancient" expresses a relative idea. Steam engines are all modern as compared with the potter's wheel, or the water-mill or the loom. But compared with each other they are ancient and modern. Anyone in doubt can settle the point by a visit to the South Kensington Museum. The distinguishing feature of the old-time engine room was extreme simplicity—fewness of parts. There was a cylinder and a piston, a crosshead, two side levers, a connecting rod, a crank shaft, a long D slide valve worked by a single eccentric with a gab and a pin. Then there was a jet condenser, an air pump, and a feed pump, and that was about all. An ordinary copper kettle containing tallow stood on the cylinder cover that it might be kept hot. A little was administered now and then on the up stroke through a cock, when the vacuum sucked it in, and so stopped the groans of the piston. That was the equivalent of up-to-date forced lubrication. The boiler pressure was 10 pounds to 15 pounds, and the consumption of fuel was at the rate of about 6 pounds per indicated horse-power per hour. To make a complete drawing of such a marine engine was a very simple affair. Some excellent examples are to be found in "Bourne on the Steam Engine." There is still in existence a very scarce manual of the marine engine, written by Maine and Browne, and published under the auspices of the Admiralty, for the use of naval engineers. Among the instructions given are those relating to the precautions to be taken when a ship was going into action. It will be remembered that the boilers were rectangular—much the shape of a biscuit tin with the corners rounded off. The engineer was instructed to have ready numerous pieces of boiler plate and short lengths of timber. If a round shot came through the side of the boiler the hole was to be stopped by a piece of plate, bedded on canvas coated with red lead putty, and secured in place by wedging a timber strut between it and the ship's side. Before going into action the pressure was always to be let down below that of the atmosphere, so that when the hole was made air might rush in instead of steam coming out. In this way the danger of a damaged steam pipe was minimized. This reads like a jest now; but it was not a jest. It was a serious Admiralty instruction. We have not heard of any instance in which repairs were effected in this way; nor, indeed, of much mischief ever having been wrought by round shot in engine or boiler rooms. It was a curious fact that during the

Crimean war a paddle wheel was never disabled, although the paddle boxes and paddle box boats of steam frigates like the old "Terrible" were knocked to pieces.

Of the modern marine engine room most of our readers have no doubt an idea. To many of them it is familiar. Its contents constitute a maze of mechanism. There are miles of piping; hundreds of valves of the most varied kinds. There are two sets of engines instead of one; there are at least six cylinders instead of two; and the piston valves are so large that it is easy to mistake the valves for the cylinders from the upper platform. And then the auxiliaries, the forest of pumps, the feed heaters, the distillers, the filters, the lubricators, the expansion gear, the reversing engines, to say nothing of dynamos, and refrigerators, and hydraulic machinery, and a multitude of small things, each and every one demanding attention. Then the pressure, 180 pounds to 220 pounds, which tries every joint. The old-fashioned "shovel" had a very easy and irresponsible life compared with that of the marine engineer of the present day.

Let us ask ourselves the cause of the change. Why has complication taken the place of simplicity? Why are there so many things in an engine room that our fathers or grandfathers did without? And did without while opening up the commerce of this country with the world, and entering on voyages and undertaking risks of very great magnitude. The answer is quite easily given. They are one and all the result of a desire to save fuel. There was only one effectual method of doing this. Pressures must be raised and steam expanded. Formerly the jet condenser was used. It was simple, cheap, demanding little or no attention, giving an excellent vacuum at a very moderate cost. The boiler was fed with sea water, and about one-fifth of the feed had to be blown hot overboard. This represented a loss, but not a great one. Attempts were made to raise pressure, but about 30 pounds was the limit. At the higher temperatures salt was just as soluble as at low, but sulphates of lime and magnesia become insoluble, and being thrown down on the heating surface formed a hard scale. It became clear that if pressures were raised the boilers must be fed with water free from scale-making impurities. Enter the surface condenser upon the scene. Great difficulties were encountered, and dozens of patents taken out for getting over them. It was all experiment; and as usual the solutions of the problem were supplied by practical men. Like most other things in a ship, the surface condenser as we have it is a survival of the fittest. With it came centrifugal circulating pumps and other delights for the marine engineer. The coal consumption fell. A horse-power could be had for 5 pounds per hour. There was no longer a limit to boiler pressure, and 50 pounds came in, and with it various forms of the compound engine. Need it be said that the result was more complication? But consumption fell. A compound engine with 50 pounds pressure got on with as little as 3 pounds or 3½ pounds of coal per indicated horse-power. The cylindrical or Scotch boiler took the place of the box boiler, and pressure rose to 80 pounds. There it remained for some time. The introduction of steel, bigger plates, and better machine tools was followed by gradual rises. A third cylinder was added, and pressure rose to 160 pounds. Finally came the quadruple-expansion engine, with four cylinders and four cranks, and 220 pounds pressure, and a horse-power for about 1 pound of coal.

All the changes which have taken place during the last half-century have resulted from the search for economy of fuel, and the discovery that it could only be secured by raising pressure. All that is said and argued on theoretical grounds about the multiple-cylinder and the "heat trap" has no practical significance. The reason why the modern is so much more economical than the ancient marine engine is simply that it works between greater temperature ranges. But for mechanical reasons high pressure steam cannot be worked in single cylinders; hence compounding. Much that is of interest will be found by the marine engineer of to-day who will ask himself why things are as they are, and not as they were. Let us suppose for a moment that no possible advantage could be gained by carrying a higher pressure than 20 pounds. If that were true then the modern engine room would differ very little indeed from the ancient engine room. Rectangular boilers would still be used, because they take up less space than Scotch boilers. It is probable, but far from certain, that surface condensers would be used. Improved devices for handling the engines would be adopted. Various precautions would be taken to prevent waste of heat and leakages of air to spoil the vacuum. But there would be no compounding, and the auxiliaries would be few and far between; there would be less stress on everything, and very much smaller powers. But all this only goes to substantiate the argument that the difference between the ancient and modern engine room is due almost altogether to the augmentation of pressure. Complication has gone hand in hand with rise of pressure. Each change has entailed another, and so would change have gone on to the end of all things. Now we have the turbine; it promised simplicity. It remains to be seen if the promise can be kept. The turbine engine room certainly calls up few memories of the past. Its complexities and troubles are all its own. They must be serious indeed if they exceed those dealt with by naval engineers in charge of the reciprocating engines of a modern warship.

TIRE INFLATION AND ADJUSTMENT.

THE manufacturers are universally agreed, after spending much time and money experimenting and testing, that certain air pressures should be maintained in all tires according to the weight they are to carry. The necessary minimum pressure is stated by manufacturers to be as follows:

3½-inch tire	60 pounds pressure
4-inch tire	75 pounds pressure
4½-inch tire	80 pounds pressure
5-inch tire	90 pounds pressure
5½-inch tire	90 pounds pressure

Inasmuch as tires are manufactured and sold under a guarantee for a certain mileage, the guarantee is based on the understanding that they will be kept up to this pressure at all times, and a number of makers attach a label or brand to the tire stating the required pressure for that particular size of tire. If, therefore, cars are run with tires inflated to a lower pressure, replacements cannot be justly expected from manufacturers. When tires are returned for adjustment because of blow-outs, chauffeurs doubtless believe, in the majority of instances, that sufficient pressure has been maintained to justify the claim. This, of course, is a matter of approximation or opinion unless a pressure gage is used.

In the experience of supply departments claims are frequently made based on the statement that the right pressure was maintained, being subjected only to a test of hand pressure and looks. A test made by pressure gage indicates in nearly every case that the actual pressure is little more than 50 per cent of that required. In one instance of a 935 by 135 tire on a limousine car weighing 5,000 pounds it was recognized and admitted by the owner and chauffeur that at least 90 pounds pressure was required, and it was asserted that such was the pressure maintained, as the chauffeur stated he had been inflating tires for more than ten years, and believed his judgment could be relied on without the necessity for the use of a gage. The tires were tested in his presence, and 45 pounds and 40 pounds pressure respectively were indicated by the gage. The necessity for gages to determine the proper inflation was immediately and frankly admitted.

Tires are made of a number of layers of canvas over a spherical mold, the layers bound together with an anti-friction compound. Therefore, if they are only partially inflated they are flattened out by the weight of the car. When small stones are struck a brief and sharp depression is made in the tire, which causes a break in the innermost layer of canvas, which will soon chafe the adjoining layer, and each layer will then go in turn until the tire finally blows out. If the tire were well inflated the same stone could not make such a depression.

A partially inflated tire is also damaged by overheating, caused by internal friction of the layers, which are forced out of their natural spherical construction on which they are intended to run, causing the rubber tread to separate from the canvas, allowing the water and dirt to get in between the layers of canvas, when of course the whole tire is ruined.

These are often the causes of what the owner or chauffeur calls a defective tire, and are the occasion of just objection by manufacturers to a replacement. All reputable manufacturers are ready and willing to replace defective tires, and no trouble is found in the adherence to the mileage guarantee, but proper inflation is justly, and for the reasons stated, desired demanded.

THE PUREST WATER NOT ALWAYS THE BEST.

A GOOD drinking water possesses an agreeable flavor, which it owes to the mineral substances which it holds in solution. The most important of these salts is calcium bicarbonate, the presence of which in small quantities should be considered as a hygienic requirement of drinking water. Our organism needs lime salts for its development and even for its maintenance, because it daily loses a considerable quantity of lime which must be replaced by lime contained in the food and drink. Boussingault found that a young pig absorbed in three months about 12 ounces of calcium carbonate from water alone. The proportion of calcium carbonate in drinking water, however, should not exceed one part in 2,000. If a larger quantity is present, the water becomes heavy and indigestible. Calcium phosphate also exists in water in small quantities, held in solution by free carbonic acid. This is a still more useful ingredient of drinking water because of the part which it plays in the development of the bony structure. A full-grown man loses daily about 22 grains of lime and 60 grains of phosphoric acid.

The presence of calcium carbonate in water produces another useful result, at least in connection with the water supply of cities. Water which contains a smaller proportion of calcium carbonate than three parts in one million is incapable of covering the inner surface of lead pipes with the protective coating which prevents corrosion of the lead by the chlorides contained in all natural water and in resultant formation of small quantities of soluble and poisonous lead salts. This consideration has led several cities, including Sheffield, England, and Dessau, Germany, to add a certain quantity of lime to the water before it enters the pipes. This process possesses the incidental advantages of sterilizing the water to a certain extent and of adding a mineral ingredient which is required by the organism of the consumer.—Cosmos.

TRANSMISSION LINE THROUGH THE SALT RIVER CANYON AND OVER HIGH CLIFFS JUST BELOW THE ROOSEVELT DAM.

THE ROOSEVELT DAM.

NEW METHODS OF POLAR EXPLORATION.

AN ACCOUNT OF THE COMING ARCTIC AND ANTARCTIC EXPEDITIONS.

BY F. MEWIUS.

THE activity of recent explorers in both the Arctic and Antarctic regions has been crowned with so great success that the polar explorations of the last few years will occupy a prominent place in the history of geographical discovery. Commander Peary, who had already won celebrity through numerous polar expeditions, as well as the now discredited Dr. Cook, claims to have reached the North Pole, and Lieut. Shackleton has penetrated the almost unexplored Antarctic continent to within 112 miles of the South Pole.

These achievements show clearly the extent to which success in the attainment of high latitudes and the traversing of extensive and unknown polar regions is dependent upon the development of the technique of traveling by sledge, although the ability of the commander of the expedition is of course a very important factor. This development of the art of sledging is the result of the accumulated experience of many years. After the endeavors to find a practicable ocean passage through the polar ice to China and India had failed, the North Pole itself became the principal object of Arctic exploration. It soon became evident that little could be done with ships alone. Wherever an attempt was made to proceed northward, through Smith's Sound, along the east coast of Greenland, northward from Spitzbergen or Bering's Strait, the ship's progress was arrested by impenetrable masses of ice. At the beginning of the nineteenth century journeys by sledge were undertaken, and since that time the sledge has been the most important auxiliary of the pole seekers and other Arctic explorers, the ship serving only as a convenient point of departure for the sledge parties. The difficulties which these parties had to contend with may be conceived when we remember that the polar ice is often accumulated by ocean currents and other agencies into masses of hills, intersected by wide stretches of open water, and that the entire mass of ice often drifts with the current. Furthermore, it is not possible to travel by sledge over the ice, except during a short period in spring. In order to use this period to the best advantage and to provide the expedition with good sledges and dogs and suitable equipment, expert knowledge is required. In this respect the greatest experience has been acquired by Peary, who finally adopted the plan of employing Eskimos as his assistants.

Meanwhile the dirigible airship is preparing to enter the field of Arctic exploration. It is true that Wellman has not won his hoped-for laurels, but the reason of his failure may be found in the character of his preparations. This fact increases the interest which attaches to the projected German Polar Expedition, with Zeppelin airships, the preparations for which are being carried out, as the expedition itself will be conducted with characteristically German care and thoroughness. The object of this expedition is not so much the attainment of the North Pole as the advancement of science. In particular, the meteorological conditions of the Arctic region will necessarily be very thoroughly studied. According to the plan which has been decided upon, a preliminary expedition will start during the coming summer, when the German exploration steamer "Poiseidon" and the Norwegian Arctic ship "Phoenix" will proceed to Spitzbergen in order to seek and prepare a suitable place for an airship station. It will also be necessary to make investigations concerning the polar ice, the southern limit of which is usually found north of Spitzbergen at latitude 81 deg. A still more important problem is the development of a suitable method of anchoring, so that the airship can stop on its journey toward the pole for the purpose of taking soundings. Two Zeppelin airships will be specially constructed for the expedition. One of these vessels will perform the voyage of exploration, while the other will remain at the station in Spitzbergen, as a reserve in case of need. The exploring vessel will keep in touch with the station by means of wireless telegraphy. In order to prove the capability of the new airships to perform their allotted tasks, they will be dispatched on journeys over sea from Hamburg during the summer of 1911, and will not be taken to Spitzbergen until the following year, when the voyage of polar exploration will begin. With this method of preparation it is reasonable to expect a successful accomplishment of the main expedition, especially as an airship has a freedom of movement which is not possessed by any other vessel or expedition in the ice-covered Polar Sea.

This sea is, however, one of the most important fields of exploration in the Arctic region, consequently much interest attaches to Capt. Amundsen's projected expedition with the "Fram." Amundsen's journey, like that performed by Nansen with the "Fram," will be accomplished by drifting. The vessel will proceed through Bering's Strait, allow itself to become frozen in the ice pack, and then drift onward with the current. This journey is likely to occupy three or four years, during which the members of the expedition will be exposed to dreadful loneliness and monotony of life in the Arctic, but it offers a prospect of traversing the immense and hitherto unexplored region which lies between Alaska and the North Pole. In connection with Amundsen's expedition, explorations in the Atlantic Ocean will be undertaken this summer, after which the ship will start on its long journey to Bering's Strait *via* Cape Horn.

CAPT. SCOTT (SEATED) AND HIS FIRST OFFICER, LIEUT. EVANS.

LIEUT. WILHELM FILCHNER.

It is probable that the Russian government will also send an expedition to the Arctic this summer, in order to make explorations along the coast of Siberia in the interest of a possible future navigation of the Northeast Passage. Two vessels have been constructed for this purpose with especial attention to their capability as ice breakers. The doubtful point appears to be the appropriation of the large sum of money which will be required for the expedition itself and the auxiliary land expedition along the coast of the Taimyr peninsula.

The well-known Norwegian Arctic explorer Isachsen expects to complete during the coming summer the explorations begun last year for the purpose of making a scientific study of the coast and interior of the northwestern part of Spitzbergen. Of especial practical value are Isachsen's cartographic photographs and drawings of the indentations of the coast and his soundings, which make it possible for even large tourist steamers to visit these fjords with perfect safety. On the east coast of Greenland a Danish expedition, commanded by Capt. Mickelsen, has been waiting since last autumn with the object of seeking during the summer for the lost records of Mylius Erichsen, who perished in 1907 in an attempt to cross the ice-covered interior of Greenland. In connection with this expedition the Danish explorer Knud Rasmussen will make studies of all the Eskimo tribes. He will start from Cape York, north of Melville Bay, and proceed to Hudson Bay and through the Eskimo territory extending along the north coast of America to the Aleutian Islands. Three years are allowed for the accomplishment of the work.

Antarctic exploration will this year take the unusual form of a race for the Pole between Englishmen and Americans. Encouraged by Peary's success in the Arctic, the Geographic Society of Washington and the Peary Arctic Club of New York quickly decided, at Peary's suggestion, to fit out an expedition to compete with the British Antarctic Expedition in command of Scott. Both expeditions will start this year and both have the same main object, the attainment of the South Pole; but they will seek this goal from opposite points, the English expedition starting from Victoria Land, the American from Coat's Land in Weddell Sea, discovered in 1904 by Bruce. Both expeditions will be equipped in the best possible manner. In the "Terra Nova" Capt. Scott possesses an excellent vessel, and he will carry sixty sledges and one motor sledge for the use of his various sledge parties. Ponies and dogs are now being procured in eastern Siberia for the use of the expedition. Dr. Wilson, a member of the "Discovery" expedition, is the chief of the scientific staff. The "Terra Nova" will leave England in July, and in December will reach New Zealand, whence the journey will be pursued to Victoria Land. The winter station will be established, probably, in McMurdoch Bay, in the vicinity of the volcanoes Erebus and Terror.

The American expedition will make use of Peary's vessel, the "Roosevelt," and will be commanded by Capt. Bartlett. On Peary's advice, only dogs will be used for drawing the sledges. In September the expedition will leave Punta Arenas, in Tierra del Fuego, the most southerly settlement in the world, and will proceed to Weddell Sea, where its first task will be the rediscovery of Coat's Land.

It is not easy to decide which of these expeditions, the English or the American, is most likely to reach the goal. Scott's point of departure is the nearer to the South Pole, and from it set forth the successful sledge parties of Scott in 1902 and Shackleton in 1909. For the purpose of geographical exploration, however, it is very advantageous that a second attempt to reach the Pole by a totally different route will be made. In this way it is probable that our knowledge of the extent of the Antarctic continent will be greatly increased. For, though we know little of the Antarctic continent, its existence can scarcely be doubted. With the exceptions of Victoria Land and King Edward VII. Land, all land masses which have been reached or seen by former expeditions lie at very great distances from the pole and about in latitude 66 deg. These regions include Wilkes Land, Kaiser Wilhelm Land, Kemp Land, and Enderby Land on the one side; and on the other, Graham Land, Alexander I. Land, and Peter I. Land, contiguous to which is the region discovered by the Charcot expedition, extending along the 70th parallel to about 125 deg. of west longitude.

By a remarkable coincidence a great German South Polar expedition, which possibly will begin operations during this year, has suddenly been projected. Lieut. Filchner, celebrated through his extensive travels in Tibet, is the originator and will be the commander of the expedition. Combining scientific zeal with great energy and indomitable courage, Filchner is the very man for this undertaking. While the attainment of the South Pole is the main object of the American and English expeditions, the objects of the German expedition are exclusively scientific, and consequently appeal to the interest of the entire scientific world. Filchner purposes to traverse the Antarctic continent and to investigate the relations between its eastern and western parts, for the purpose of deciding whether these really form a single continent or whether the western portion is merely a peninsula on the coast of the larger western land, connected with it only by a low-lying ice-covered neck of land, separating Ross Sea, adjacent to Victoria Land, from Weddell Sea, in the South Atlantic. The expedition will start from Weddell Sea, but an auxiliary vessel will proceed to Ross Sea and will establish a depot of provisions as far south as possible at the foot of the lofty cliff, for the purpose of supporting the sledge parties sent out from the principal ship. In this manner it appears possible to traverse the intervening land and solve the important question of food. The plan is for the sledge parties to return to Europe by means of the auxiliary ship from Ross Sea. The celebrated Norwegian explorer Nordenskiold says that this plan is by far the most important and most valuable of all projects of

antarctic exploration. Apart from the great problems concerning the interior of the Antarctic continent which will be solved by it, the expedition will be able to make very valuable oceanographic explorations. Filchner estimates the cost of the expedition at $300,000 with one ship, and $500,000 with two ships, and these estimates are none too high in the opinion of other polar explorers. $90,000 has already been subscribed. Filchner desires to rely upon private capital alone, in order to be entirely independent in his control of the expedition.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Illustrirte Zeitung.

A SELF-LIGHTING ELECTRIC ALARM CLOCK.

BY DR. ALFRED GRADENWITZ.

THE ingenious electrical apparatus recently designed by Prof. R. Dubosq at Bayeux, France, and pictured in the accompanying illustrations, is intended to perform the function of awakening a sleeper and of lighting an electric lamp, to assist him in rising. By extinguishing this lamp, a platinum wire is brought to incandescence on which any other lamp can be lighted in case the owner of the apparatus has no electric plant at his disposal.

As seen in Fig. 1, the apparatus consists mainly of a small wooden box with a primary battery or two pocket accumulators. This box is provided on its sides with different devices, viz., to the left (1) the handles and disengagement device, in front (2) the alarm with the index for actuating it, and to the right (3) the bell mechanism with the lighting device for the platinum wire. On the cover, the lamp is located with its reflector and a small resistance, which opposes the slight resistance of the platinum wire to the higher resistance of the incandescent lamp. The apparatus comprises essentially three parts—the actuating device, the disengagement device, and the transmission.

The actuating device, on which the working of the whole mechanism depends, consists simply of a slotted copper index *PP'*, carrying at its end a stop which can be adjusted to any point on the dial. This index is so designed that the minute hand may pass over it without touching it, whereas the hour hand, on coming into contact with it, closes the circuit. The mechanism proper of the alarm clock need not be altered in any way. In fact, any ordinary alarm clock can be used, its mechanical operation being reserved for the case of a breakdown in the electrical arrangement.

The disengaging device is equally simple. It consists of a double electromagnet and three levers, represented in Fig. 1 to the left (1). This electromagnet will act by attraction immediately on what is called the "disengagement lever," *D*, which communicates, first, through a slot with the lever *c*, which actuates the lighting circuit (represented in full lines) and, secondly, through a projection with the lever *C*, which actuates the bell circuit (shown in dotted lines).

From the above, it will be readily understood how the mechanism operates. By switching in the lever *c*, the circuit is interrupted at *b*, and, by switching in the lever *C*, the other circuit is broken at *C''*. The switches are then brought into their proper position, viz.: *B* into the position *B''*, and *e* into the position *e''*, and, finally, the actuating index is brought into contact with the hour hand of the alarm.

The inside terminals *AA'* will then be connected with the two terminals of the small battery contained in the box, the electric current taking the following course: From *A* to *B*, *B*, *B''*, *C*, *C''* to the electromagnet *E*, over *F*, the body of the alarm, and then over the hour hand to *P*, *K*, *H* and *A'*. As the electromagnet at the same moment attracts the disengaging lever *D*, the lever *c* is again brought into contact with *b* by a spring connected to it, and the lighting current, coming from *aa'* will go directly to the lamp, whereas the lever *C*, becoming disengaged, drops into the position *C'''*, leading the current through another circuit to *A'*, while traversing the bell arrangement; the latter does not stop ringing before the switch *B* has been brought back to its disengaging contact *B'*. If, now, the switch *e* be put back to *c'*, the lamp is extinguished, and by pushing it on to *c'''* there is lighted the platinum wire, the luminous intensity of which is controlled by a small rheostat, located in the cover. The sleeper must obviously get up to stop the alarm.

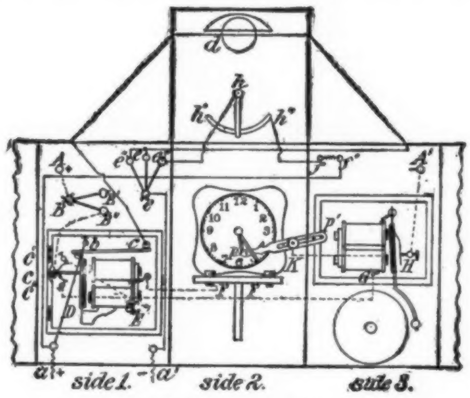


FIG. 1.—CIRCUITS OF THE CLOCK.

FIG. 2.—AN ELECTRIC ALARM CLOCK.

The sleeper must get up to stop it.

TRANSMISSION OF ELECTRIC WAVES.

FROM the results of experience in wireless telegraphy in various directions and at all hours of the day and night, it appears that the ether does not always possess the same power of conducting electric waves, but that its conductivity varies greatly at different times. The more intense the solar radiation, the smaller is the conductivity of the ether. Hence the prevalence of atmospheric electrical disturbances at night is due to the fact that the greater conductivity of the ether at night makes perceptible the electric waves produced by storms so distant that they cannot be detected in the daytime. For the same reason wireless dispatches can be sent greater distances at night than by day. Finally, it may be concluded that a wireless station of given construction does not possess any definite and constant radius of action. A station which can send messages to great distances at 50 degrees north latitude may have a very restricted range in the tropics, owing to the greater intensity of solar radiation.

STEAM TURBINE ELECTRIC LOCOMOTIVE.

AT the opening meeting of the Glasgow University Engineering Society, October 28th, 1909, Mr. Hugh Reid, managing director of the North British Locomotive Company, of Glasgow, in his address as honorary president of the society, made public a most interesting description of "the first steam turbine electric locomotive." This new type of locomotive is now under construction on the Reid-Ramsey system, in the works of the North British Locomotive Company.

The Heilmann steam-electric locomotive, built in 1894, was considered the most notable attempt to introduce independent, self-generating electric units that might operate over existing railway systems without necessitating any electrical equipment for the railways themselves. The Reid-Ramsey, though a development of the Heilmann idea, is said to be founded on a very different and much more practical basis.

The boiler in which the steam is generated is of the ordinary locomotive type, fitted with a superheater. Bunkers and water tanks at both sides of the boiler carry the coal and water supplies. A turbine of the impulse type, with a speed of 3,000 revolutions per minute, coupled directly to a continuous-current, variable-voltage dynamo or generator, receives the steam led from the boiler. The dynamo supplies electrical energy of from 200 to 600 volts to four series-wound traction motors, the armatures of which are built on the four main or driving axles of the locomotive.

The exhaust steam from the turbine passes into an ejector condenser and is, together with the circulating condensing water, delivered eventually to the hot well. Owing to the fact that the steam turbine requires no internal lubrication, the water of condensation is free from oil and consequently is returned from the hot well directly to the boiler by means of a feed pump.

As the water evaporated by the boiler is returned to the boiler continuously, the supply of water carried in the tanks is actually circulating water for condensing purposes. This condensing water is circulated within practically a closed cycle by means of small centrifugal pumps driven by auxiliary steam turbines placed alongside the main turbine and dynamo. The cycle of the condensing water is from the tanks through the first pump, then through the condenser, where it becomes heated in condensing the exhaust steam, then to the hot well. From the hot well it passes through the second pump to the cooler, situated in front of the locomotive, where the full benefit of the blast of air caused by the movement of the locomotive, aided by a fan, is utilized for cooling the hot circulating water. After passing through the cooler the water is returned to the supply tanks ready for further condensation duties.

The locomotive boiler is deprived of the usual exhaust blast which induces the draft through the firebox and tubes, owing to the condensation of the exhaust steam. A forced draft, provided by means of a small turbine fan, replaces the reduced draft in the new locomotive. The fan is placed within the cooler so that it will deliver hot air to the boiler fire and at the same time assist the current of air through the cooler.

The small switchboard and the instruments required, the controller for grouping the four motors in series—series-parallel and parallel, according to the drawbar pull to be exerted—and the regulator for controlling the voltage in the electrical circuit and, consequently, the speed of the train, are all placed under the driver's platform within easy reach.—American Journal of Steam and Electrical Engineering.

ALEXANDER AGASSIZ, FOR.MEM.R.S.

ALTHOUGH the great American oceanographer had reached the age of seventy-five, few of his friends were prepared to hear of his death, which appears to have taken place, somewhat suddenly, on board the S. S. "Adriatic" on March 28th, while on a voyage back to the United States.

The distinguished son of a famous father, Alexander Agassiz was born in Switzerland but naturalized in America; yet, so cosmopolitan was he in his tastes and habits, that if ever an individual deserved the title of "a citizen of the world" he was the man. Up to the age of thirteen he was educated in his native land, but, proceeding to the United States in 1848, he went to the Harvard University, where—as a student in chemistry and engineering—he obtained his degree of B.Sc. at the age of twenty-two. After spending a short time as a member of the United States Geological Survey, young Agassiz became a mining expert, and so successful was he in this profession that, acquiring possession of valuable properties in the Lake Superior region, he rapidly made a very large fortune in connection with the copper mines.

The love of natural-history studies, however, which he inherited from his father, soon made itself felt; at first he assisted his father as curator of the Museum of Comparative Zoology at Harvard. As his wealth increased, he was able to benefit that institution, not only by specimens collected during his extensive travels and by defraying the cost of many expensive publications, but also by gifts of money up to 100,000*l*. After the death of his father he acted as curator of the museum for eleven years. Beginning with the study of marine ichthyology, he subsequently came to be acknowledged as a great authority on the Echinodermata, so that, on the return of the "Challenger" expedition, he was asked to undertake the report of the Echini collected during the voyage.

But the work for which Alexander Agassiz will be chiefly remembered was that which, during nearly forty years, he carried on at his own expense in connection with oceanography. The United States government, with the greatest liberality and consideration for the interests of science, allowed him from time to time the use of their surveying vessels, the captains of which were instructed to place themselves virtually under the order of Agassiz himself. The naturalist, aided by a staff selected and paid by himself, carried on soundings and dredgings in every part of the globe, special attention being devoted to the study of coral reefs. Beginning, in 1877, with the study of the Gulf of Mexico, the Caribbean Sea, and the Atlantic coast of America, Agassiz continued his work in 1880 by investigating the surface fauna of the Gulf Stream. Besides working out the details derived from the study of collections made during these voyages, the results of which were published in connection with the Harvard Museum of Comparative Zoology, Agassiz wrote a well-illustrated account of his work, "The Three Voyages of the 'Blake'," in two volumes.

In 1891 Agassiz transferred his attention to the western shores of the United States and Central America, investigating the seas around the Sandwich Islands, and paying special attention to the coral reefs there, between 1892 and 1894. His explorations were extended during 1895-6 to the Great Barrier Reef of Australia, and in 1897-8 to the Fiji Islands. In 1899 and 1900 he was able to undertake a cruise among the various groups of coral-islands lying between San Francisco and Japan. In 1901-2 Agassiz commenced his study of the Indian Ocean, paying especial attention to the Maldive Islands and their surroundings; and, in order to complete the examination of portions of the Pacific that he had not already visited, he devoted the years 1904-5 to a cruise among the important island-groups of the eastern half of the Pacific Ocean.

The intervals between his several voyages were occupied by Agassiz in the study of his enormous collections and the preparation of memoirs dealing with the results obtained. These were issued, regardless of expense as to their illustration, in the publications of the Boston Society's Museum of Comparative Zoology. No fewer than thirty volumes of memoirs and fifty-three volumes of bulletins are devoted to the results obtained from the study of these collections by Agassiz and the various specialists who assisted him. His own favorite place of work was Paris, where rooms were always allotted to him in the Museum of Natural History, and he had the fullest access to scientific libraries.

Of the value and importance of the results of these voyages it is impossible to speak too highly. Perhaps the most striking of the conclusions arrived at by him are those relating to great movements which have taken place in the bed of the Pacific in comparatively recent geological times. This is evidenced by the numerous upraised coral-reefs which, following Dana, he described; in many of these the limestone rock, now at elevations of 1,000 feet and upward, has been more or less completely converted into dolomite.

It is not necessary, in face of the above statement of facts, to add that Agassiz was a man of indomitable energy. He thought as little of crossing the Atlantic as we do of crossing the Thames, and death met him at last while still "on the move." Of his courage, a remarkable example is told concerning an altercation he had with a military officer in a crowded restaurant in Germany; on that occasion he did not hesitate to resent an insult by a blow, though fortunately any serious result from the rash act was prevented by the interposition of a number of judicious friends of the officer, aided by American and English visitors who were present. In early life, Alexander Agassiz exhibited something of the dogmatic habit of mind that distinguished his illustrious father; but, mellowed by age and constant intercourse with other men, he became in after life strikingly open-minded and ready to listen to arguments, even those that told against his most cherished convictions. Those who were privileged to enjoy his friendship in his later life knew him as a man of ardent enthusiasm, restless energy, and charming bonhomie, but also as one patient in discussion, and always ready to listen to facts and reasonings from whatever quarter they came. His generosity was unbounded, and he was always ready to place his abundant materials at the service of young men who were qualified and willing to engage in their study.

In every scientific circle of Europe, as well as in those of America, Alexander Agassiz was well known, and in all of them his loss will be deeply mourned. In France he received the Légion d'Honneur, and in Germany the Order of Merit. In this country he was for many years a Foreign Member of the Royal Society. Only last year the Royal Geographical Society awarded him the Victoria research medal, and we may fitly conclude this notice with the verdict of the president in announcing the award—a verdict in the justice of which all must agree—"He has done more for oceanographical research than any other single individual."
—John W. Judd in Nature.

PROBLEMS IN MARINE CONSTRUCTION.*

PROCEEDINGS OF THE INSTITUTION OF NAVAL ARCHITECTS.

The current problems of most interest to those engaged in the branches of science associated with marine construction are usually brought into high relief at the annual meeting of the Institution of Naval Architects, and in the present year this has been particularly the case. This is as it should be, because the Institution, which is to celebrate its jubilee some three months hence, is the nerve center of the profession in this country—if not, indeed, in the world. The action of the Council in recent years, in insuring a high standard of attainment on the part of the new members elected, is therefore to be commended. We are glad also that it has been decided to apply for a Royal Charter of Incorporation, because this will not only confer direct advantages on the Institution in the matter of its finance and property, but will add a well-merited dignity. This distinction is the more justifiable in view of the direct service rendered to the nation not only by the Institution collectively, but by the component members. Mr. Trevent was perfectly accurate when, in moving the resolution in favor of the application for a Royal Charter, he stated that at the time the Institution was first organized naval architecture in Britain was not on a scientific basis, and that we had to look to France for inspiration and example. The literature of our neighbors and the marvelous success of their ships were in some measure a reproach. But so soon as Scott Russell, Sir Edward Reed, Sir Nathaniel Barnaby, and other originators of the Institution perfected their organization, there was created an aspiration to excel in scientific shipbuilding, with a medium for interchange of views, which at once placed the industry on a more sound foundation. The result has been that the British navy has since led the way, so far at least as design and construction of warships is concerned, whereas in the merchant marine we have established a position of superiority in the efficiency of high-speed merchant steamers and in the economy of cargo-carrying ships, as well as in that great extent of shipping which is more or less consequent upon our insular position and upon the extent of our colonial possessions.

The meetings this year have shown that in the grasp of scientific problems the Institution maintains its high standard. This is reflected in the complete report we publish in this issue of the discussion on the propeller problem. The discussion is almost entirely consequent upon experimental research upon Froude's lines, and in this respect there is rejoicing that the jubilee meeting should be signalized by the formal opening of the National Experimental Tank at Bushy, where experimental research will be carried on continuously without interference by the commercial element, and without being subject to the claims of education. We have already given expression to the national sentiment with reference to the munificence of Mr. Yarrow's action in providing funds for the construction of this most important accessory to the National Physical Laboratory, and his practical interest in the whole question. We are glad that there will be no lack of funds for the maintenance of the property, and for the prosecution of research. The Governing Body of the National Physical Laboratory is sufficiently representative to insure that the maximum utility shall be derived from the tank, and the Executive Committee of the tank have acted wisely in accepting Sir Philip Watts's guidance in the appointment of a superintendent. We have no doubt that good will result, in view of Mr. G. S. Baker's personal attainments and his work at the Admiralty. The composition, too, of the Executive Committee, which was referred to in Dr. Glazebrook's paper, published in last week's issue, is of the first importance, because the work of experimental research calls for very special qualifications, not only on the part of the officer principally responsible, but also on that of the guiding executive body. Broad knowledge and wide sympathies are essentials. There must be the true spirit of imagination, and yet of more importance is the characteristic of concentration. On the one hand, it is important that every element that may conduce to success must be regarded in proportion to its potentialities. Proposals must be considered, even although they may be contrary to preconceived ideas or to current practice. There should, on the other hand, be the faculty to measure the influence of variants, and to assess their due proportion in arriving at conclusions. Thus imagination must play a large part in determining the lines of investigation, but in detail work there must undoubtedly be rigid exclusion of everything excepting absolutely proved results. There is, however, sufficient example for the student of character in the history of engineering alone, and without attempting to exhaust the list, reference may be made to James Watt, Robert Napier, John Elder, and to Robert Froude, whose work, it will be found, combined that recognition of possibilities which belongs to imagination, and that strict regard for accuracy of detail which is so essential in scientific deduction.

We have not made reference to the quality of patience as a requisite in overcoming the monotonous influence of repetition work, which may always be classed more or less as drudgery. In the paper by Mr. Luke this quality, as well as the others above mentioned, must be inferred, because we have here the results of some 2,000 experiments made with one model, set out with brevity and lucid explanation, and followed by deductions of considerable influence from the point of view of practical design. Here we may interject the remark that Mr. Luke's firm—Messrs. John Brown & Co., Limited—deserve credit for their public-spirited action in putting these results at the disposal of the profession, because they have been evolved at their own tank, as the result of an expenditure of much time and money; this credit is the greater when we recall that they have handsomely subscribed to the maintenance of the National Experimental Tank. Mr. Luke, in his paper, followed the lines of Mr. Froude, the pioneer in such investigations; but whereas the results formerly given to the Institution showed how the general shape affects the wake factor and thrust deduction in the case of many different models, Mr. Luke has taken one model representative of the average type of twin-screw steamer, so that he has been able to eliminate every variant excepting those which affect the particular issue. The deductions made relate most directly to the problems of the propeller in its position relative to the skin of the ship, the direction of rotation, size, etc. As this is one of the elements in ship propulsion regarding which there is less definite information than on any other, we commend the contributions made, not only by Mr. Luke, but by Prof. Henderson, of the Royal Naval College at Greenwich, and Mr. T. B. Abell, also of the Royal Corps of Naval Constructors. A long and suggestive discussion followed the reading of these three papers.

Mr. Luke seems to have given food for reflection as to whether the inward or outward-turning screw is the more efficient. Mr. D. W. Taylor, of the United States Navy Experimental Tank, who has also done valuable experimental research work on propellers, also combats the general idea that the inward-turning screw is preferable. Equally significant are Mr. Archibald Denny's observations on this question, as he also combines a knowledge of the results of tank work with those given by trials of the completed ship. Mr. Denny gave results of trials with the ship on the measured mile, where the only variant was the direction of rotation of the screws, when the outward-turning screws gave superior efficiency. Very significant also was the recognition of the possibility of tank experiments differing in their results from those attained in the actual ship on the measured mile, with respect at all events to propellers. The possessors of tanks are, however, always careful thoroughly to test their ships and to compare the data with those evolved by the model experiments.

This, of course, must not be accepted in any way in disparagement of the value of experimental tank work in its relation to practical shipbuilding. As a rule, in tanks owned by private firms, the current work is so extensive that general experimental research cannot be undertaken, and, as a consequence, the National Experimental Tank will be of great service. By "general experimental research" we mean problems in principles rather than in details. In such cases it is of the utmost importance that each series of experiments should have but one essential variant, as in Mr. Luke's researches, and consequently a con-

* Engineering.

siderable amount of time must be absorbed in one set. In a previous article on the general work of the tank,* we showed that the work of experimenting, on ship models at any rate, followed Newton's "principle of similitude," re-discovered by Froude and called "the law of comparison." The broad principles are therefore simple, but have to be used with care. The practical application of the principles, as in many other forms of work in physical laboratories, makes it necessary to adopt many mechanical devices to insure accurate records; as a consequence, a large volume of the work of collating results, and reducing them to comparative standards is tedious. This raises the question as to whether experimental tanks are necessary acquisitions in educational institutions, or whether the National Tank cannot in itself satisfy all requirements in this direction. The number of experimental officers required for the direction of tanks in any country must be small, because such an apparatus is an expensive accessory even to a large shipbuilding works. Is it worth involving large expenditure to have such tanks at educational establishments in order to educate a large number of students along specialized lines which must terminate, in the great majority of cases, with the college course? Those who have the characteristics of the experimenter—the enthusiasm for work and the desire to prosecute it—might very well join Dr. Glazebrook's staff in order to gain at Bushy an intimate knowledge of the higher experimental work of the tank. Such specially trained men are only necessary for the direction of affairs; the collation of results may be done by those who have not had a special college training. This, however, is too large a question, and belongs to the wide subject of the equipment of technical institutions.

The Institution of Naval Architects has, however, judiciously combined the scientific with the practical, and while the discussion on experimental research, particularly propeller design, occupied a prominent place in the recent session, there were many other topics dealt with of direct practical value. The subject of the design of battleships, raised by Admiral Bacon, is too large to be dealt with in a general article, and, moreover, it cannot be said that any addition was made during the discussion to the general sum of knowledge of the principles on which the Admiralty have proceeded in evolving their designs, as laid down in general and clear terms by the author of the paper. The Admiralty and naval shipbuilders were well represented at the meeting, but it would seem that secrecy sealed their lips. The turbine question naturally found its way even into this discussion, and Prof. Biles put the matter of the speed of battleships with his usual perspicuity. He very properly claimed that machinery was entitled to a certain proportion of the total weight, and Mr. Parsons, by reason of the higher efficiency of his system, had enabled the dreadnoughts to be of at least 2 knots greater speed than vessels with ordinary reciprocating engines, without involving any addition to weight.

The turbine, however, came into greater prominence by reason of the papers which advocated some form of gear between the high-speed turbine and the propeller in order that both should run at the speeds which are found most efficient under given conditions. So far as warship work is concerned, the propeller coefficient of about 0.6, now realized in most cases, does not seem to justify any misgiving as to the collective efficiency of the machinery between the boiler and the propeller. In the case of low-speed vessels, however, there should be room for the interposition of speed-reducing gear. The electrical engineers were strong in their claim for the electrical gear even for warships; but it seems doubtful, with a transmission loss of from 10 to 15 per cent, if the adaptability of the system justifies its preferment. There is the difficulty of easily varying the speed; but Mr. Archibald Denny brushed this aside by contending that, by having many generating units, it would be possible to insure more variation by stopping one or more of the generators in order to suit the particular change of ship speed desired. With low speed, however, the motors would be less efficient, and there would always be the difficulty of sea-spraying, if not also of the high saline density of the moistened air at sea, affecting injuriously the insulation. Mechanical gear, on the other hand, offers great attractions; it is proved that the loss need not be more than 1½ per cent, a result which has been attained alike by Mr. Parsons's and the Westinghouse system. The continuance of the prejudice against gearing is, in its way, characteristic of the trend of thought of engineers generally; but it is forgotten that there has been great development in the quality of metals—a point not mentioned during the discussion—while there is greater precision in manufacture. De Laval has for twenty years had very successful results, notwithstanding the great reduction in speed which he adopts.

The paper read by Mr. Parsons is of enormous significance, as in the 10-knot steamer "Vespasian" he has, under exactly the same conditions, excepting only the use of turbines and gear instead of triple-expansion engines, increased the speed by one mile per hour owing to the higher efficiency of the turbine, and has reduced the water consumption, and consequently the coal consumption, by nearly 20 per cent. The weight of the reciprocating machinery was 100 tons, as compared with 75 tons for the new installation. We have thus a very considerable addition to the amount of cargo which may be carried, a saving in coal and oil, in engine-room staff, and in upkeep. In respect to this latter item there is the important advantage that the working steam pressure being very much lower than with modern economical engines, the first cost and upkeep of boilers and steam connections will be considerably less. When the "Vespasian" goes into service, the results of her voyage, when compared with the last voyage made with the renovated triple-expansion engines, will be watched with very considerable interest, as the system offers the advantage of the turbine system, and may indeed serve for moderate-speed passenger vessels, where the turbine alone may not be desirable in view of the speed developed.

The extreme simplicity of the system was commended. Mr. Parsons, in replying to the discussion, referred to the cradle-balanced frame for the pinion in the Westinghouse gear as unnecessary, because the pinion would adjust itself automatically, distribut[illegible] half the tangential push between the right and [illegible] hand teeth on each side. Neither De Laval nor he u[illegible] such a balancing arrangement, and were it required he prefers giving wheels and pinions slight rotary elasticity on the shaft.

The papers read on the application of gasoline motors to lifeboats and fishing and commercial vessels were also interesting. Mr. Barnett, in the design of his motor lifeboats, has displayed very great ingenuity, and his paper is most suggestive. Mr. Linton Hope reviewed the situation generally in regard to fishing and commercial vessels, showing that for sailing boats the internal-combustion engine could be installed for about one-half the cost of steam power, and the result was not only a considerable reduction in the crew, but, what was even more important, arrival in port in advance of the steam trawler, and on the top of the market. The earnings of each member of the crew of a motor boat were said to be nearly 50 per cent more than in the steam drifter. As regards the utility of the internal-combustion motor for use in commercial vessels, there is slow but steady development in this country, although the results on Continental internal waters seem to justify a greater rate of progress. Mr. Linton Hope suggests that the adaptation of the internal-combustion motor to existing wooden vessels may increase the number of voyages per annum to 30 per cent, which is a high estimate; but we look rather to the building of a new type of craft more suited to propulsion by this type of motor. Good results will accrue if care be taken in making the power adequate for the service. These and other similar practical suggestions were laid before the Institution, and in most instances gave rise to discussions, so that the proceedings were certainly well up to the average of those of preceding years.

* See Engineering, vol. lxxxi., page 541.

IMPURE WATER AND ITS EFFECT ON FISH.

SINCE fishes are confined to water as their natural habitat, and since water strictly pure scarcely exists naturally upon the earth, they live habitually in water containing a certain amount of foreign substances in solution—in other words, in impure water. There is also nearly aways some foreign matter held mechanically. Since these so-called impurities may vary greatly in kind and degree, the study of the reactions which take place between fishes and impure waters of various nature cannot fail to be both of theoretical interest and practical importance. Hence it is that the United States Bureau of Fisheries has published from the pen of Mr. M. C. Marsh some "Notes on the Dissolved Content of Water in its Effect upon Fishes."

It is profitable to inquire first whether these impurities are merely incidental to the life of the fish as they are to the water, or are essential and necessary. That air dissolved in the water is necessary to support fishes is a matter of common knowledge and observation, for they die quickly if the water is not aerated. It may likewise readily be shown by experiment that water containing dissolved air alone is not sufficient even though plenty of food is supplied. For this purpose, 5 liters of water were distilled through glass apparatus. Contrary to what seems the general impression, distilled water has considerable air dissolved, even immediately after the distillation. A portion of this water from the receiving flask was tested for oxygen during the distillation and contained at 15 deg. C., 5.48 cubic centimeters of oxygen per liter. Twelve quinnat salmon fry were placed in the 5 liters of water in a glass jar, with a current of air in small bubbles constantly passing to the bottom of the jar and bubbling up through the water. A control was set in exactly the same way, save that Potomac tap water was used instead of distilled water. Three and one-half hours after the beginning of the experiment, the water in each jar being at 14 deg. C., oxygen was determined. The Potomac sample held 7.25 cubic centimeters per liter, the distilled sample 7.09 cubic centimeters, each therefore almost air-saturated with oxygen. In the distilled water, after 24 hours, 2 fry were dead, after 27 hours 3 fry, after 37½ hours all were dead. All the fry in the control remained alive. During the experiment the aeration of the control was never greater than that of the distilled sample, and was usually less.

Rain water was tried in substantially the same way and with mummichogs, sunfish, perch, and trout, with the same result. The mummichogs were the most resistant, living 41 hours.

One is led to conclude from this that foreign matter other than dissolved air is a necessary accompaniment of water that supports fish life, and that water can be too pure for fishes. The law is probably of wide application, for low forms of life are known to die readily in distilled water. It is natural to infer also that death is brought about in these cases by some osmotic reactions through the gills, which bring the blood, known to contain various salts essential to the life of the fish, into intimate relation with the water. It is an assumption open to several objections to explain the death as due to the dissolving out of salts or other substances from the blood. Certain obscure poisonous products are believed to be generated in the distillation of water and, conceivably even in rain water, these may have a toxic action on fish. If so, their toxicity is neutralized by contact with many simple substances. It is known that some toxic principles in ordinary water are thus neutralized, as will appear later.

For practical fish-cultural purposes it may be assumed that a certain minimum of dissolved solids is necessary to water before it is suitable for fishes, and no doubt there is also a maximum which should not be exceeded, though a wide adaptability must exist, as some fishes can frequent both fresh and salt water. Where either of these limits lies cannot be at present stated. Of course natural waters which contain fishes furnish the safe conditions both as to quantity and quality of these necessary impurities, which are common substances—carbonates, sulphates, chlorids in combination with calcium, magnesium, sodium, and other common metals. Potomac water had in October, 1905, 240 parts per million; the spring water at the White Sulphur Springs (W. Va.) hatchery had in February, 1906, 484 parts. Neither of these amounts is objectionable so far as known. Many waters have a total solid content below 50 parts per million, and fishes inhabit waters containing no more than 20. It is perhaps true that water with much less solid matter than this would support fishes. It would be interesting to find if possible some natural water fatal to fishes solely on account of its high purity.

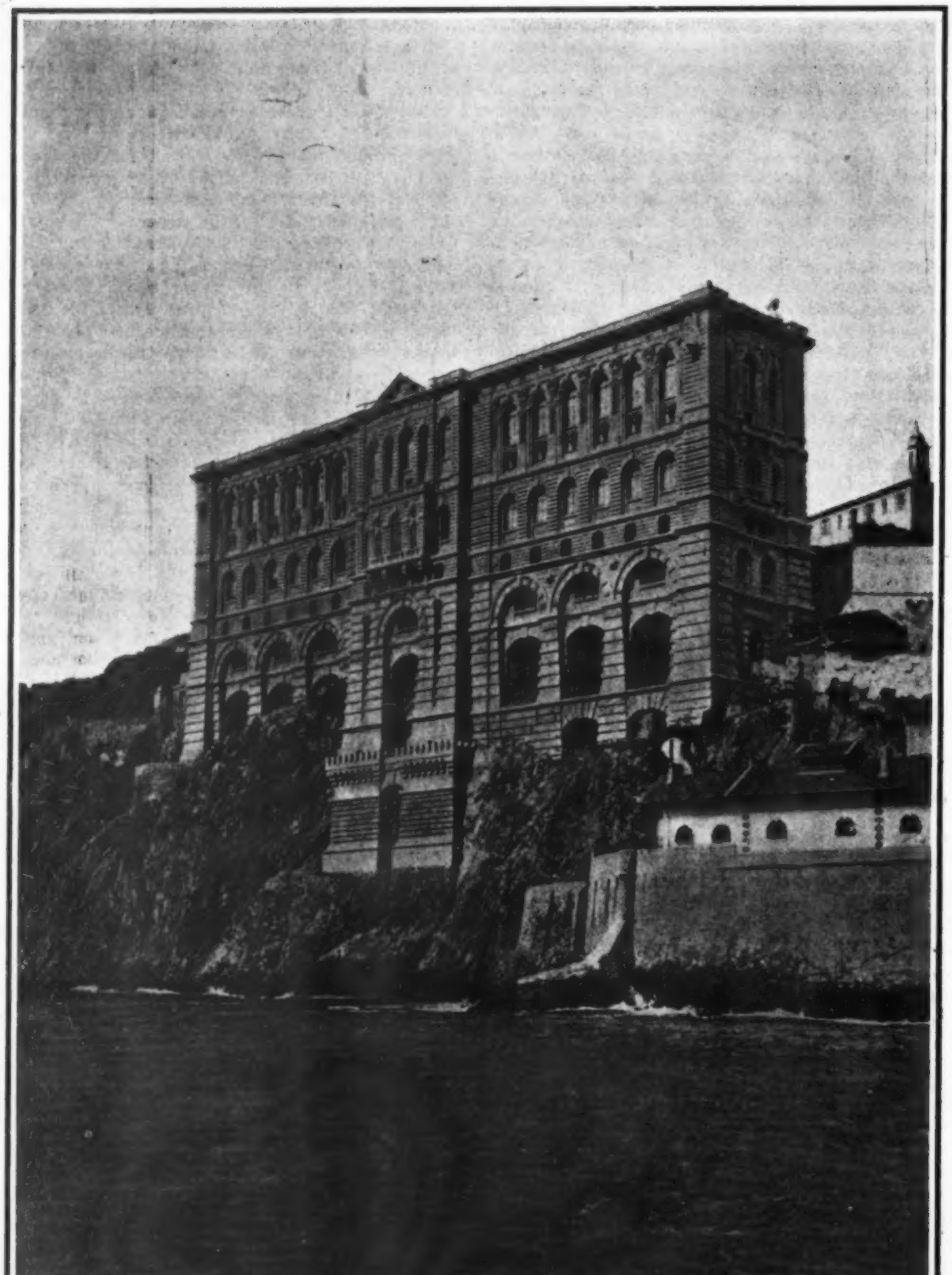
It seems that these considerations about the quantity of dissolved solids may become of some practical importance when fish are transferred from one water to another, as from one high in total solids to one low in total solids. Possibly one water may differ so greatly from another in this respect alone that a gradual transfer by slowly mixing the two waters is advisable in order that the fish may adjust itself from the one to the other. Trout, for instance, do not always thrive after transfer, even when both waters seem admirably adapted to the trout already in them.

An interesting preliminary notice by Mr. P. A. Curry of the results obtained in the research of the upper air above the Blue Hill area during the rainy season of 1909 is published in the Cairo Scientific Journal for October last. The main object was to find the direction and velocity of the wind at different heights above Roseires by the use of small pilot balloons, of which seventy-nine were released. The surface wind, which was slightly west to south, veered to southwest at 1,500 meters; at 3,000 meters northeast winds were somewhat predominant, veering to slightly north of east at 3,500 meters. From that altitude it was very constant in direction to 6,000 meters, after which it backed slightly to northeast at 9,000 meters, then veering again to east at 12,000 meters. One balloon which rose above this showed a due east wind at 13,000 meters and 14,000 meters, veering to east-southeast at 18,000 meters. Up to 3,000 meters the velocity averaged little more than 5 meters per second, increasing to 10 meters per second at 6,000 meters, it then decreased to 8 meters per second at 7,000 meters, and remained fairly steady up to 10,000 meters. Above this altitude the velocity increased rapidly. The results show a fairly steady circulation whether rain falls or not, and the limiting height of the upper easterly drift does not decrease on dry days, as was found to be the case in Abyssinia.

THE OCEANOGRAPHIC MUSEUM AT MONACO.

A DESCRIPTION OF THE NEW BUILDING.

THE inauguration of the Oceanographic Museum at Monaco took place on March 28th in the presence of representatives of the governments and navies of France, Germany, Italy, Spain, and Portugal, and a great gathering of men of science of all nations, who were invited by the Prince of Monaco, and entertained



THE OCEANOGRAPHIC MUSEUM OF MONACO.

as his guests in his ancient palace at Monaco and in various hotels in Monte Carlo. The inaugural *fêtes* lasted for four days; they were planned on a scale of magnificence rarely attempted, and drew upon the resources of art in a manner which we believe has never been paralleled. It would almost appear as if the design were to show that science, no less than pleasure, was a fitting theme for the exercise of art as exemplified in painting, poetry, and music; and that, in any case, the dedication of a great international scientific institution, provided by the princely munificence of an individual, was no everyday matter, to be passed by unnoticed save by the specialists immediately concerned.

The inauguration was an interesting function, which could not fail to impress the most regardless pleasure seeker in the gayest haunt of the Côte d'Azur with the thought that science, even in, perhaps, its least known department, was a thing of high importance. To us the fact that "someone had blundered" and no admiral of the British fleet was there to join the high German, French, and Italian officers in offering a tribute to the scientific study of the sea was a cause of humiliation. It is little short of a disgrace that the country in which modern oceanography was created, and the navy the "Challenger" of which revealed the wonders of the ocean as a whole, were brought to the attention of the gathering only by the Prince's generous recognition in his inaugural address of British pre-eminence in oceanographical research, and in the name of the ship engraved on the façade of the new building. We know, of course, that the breach of international good manners was due to no intention on the part of the King or of the Prime Minister to inflict a slight upon a noble enterprise, but the effect was none the less deplorable, and on behalf of the British scientific public we desire to give expression to this feeling in the most emphatic way. The official representation of the Royal Society, the Royal Society of Edinburgh, the Royal Geographical Society, and the "Challenger" Society showed at least the good will of British men of science.

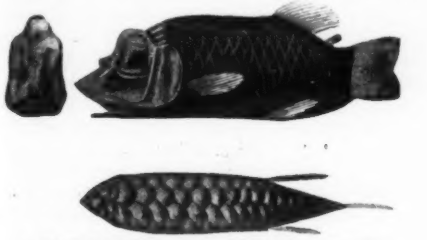
It seems more appropriate to occupy this article with a short description of the museum itself than with details of the formal speeches at the ceremonial inauguration, the performance at the opera, the pageant in the harbor symbolizing the landing of Hercules, mythical founder of Monaco, in a blaze of fireworks, and the concluding reception by the Prince in the palace. One evening was devoted to a series of lantern demonstrations, by Lieut. Bourrée, which proved of extraordinary interest on account of the kinematograph representation of the routine of work on the "Princesse Alice" in handling the various oceanographical instruments and appliances at sea.

The Prince of Monaco has devoted an increasing amount of time to deep-sea investigation since he commenced his observations on the Gulf Stream in the sailing yacht "Hirondelle" in 1885, and, as a result of his work in that vessel, in the auxiliary steam yacht "Princesse Alice," and in his present splendid vessel "Princesse Alice II.," he had accumulated, by 1898, so large a collection of natural-history specimens that he resolved to build a museum in which to house them. On April 25th, 1899, the foundation stone was laid on the southern face of the cliff which bounds the peninsula of Monaco, and the great building designed by M. Delefortrie has now been completed and equipped, and was formally inaugurated on March 28th this year. The first object has been greatly enlarged, and the Oceanographic Museum as it is established to-day contains more than the nucleus of a collection gathered from all investigators of all the oceans illustrative of the whole science of oceanography. On the face of the cliff the foundations of the museum are almost at the level of the sea. Two stories are built facing the sea, with the rock as their rear wall, and the third story is on the level of the rock, forming the ground floor of the main frontage, which faces north. The material is the extremely fine-grained white limestone of La Turbie quarries, on the mountains behind Monaco.

The ground plan of the principal floor includes a central hall twenty meters square, with a wing on each side forty meters long by fifteen wide, the whole frontage being a hundred meters. The decoration of the front of the building includes representations in relief of deep-sea invertebrates and fish, and the whole is crowned by the Prince's arms and a gigantic albatross and sea eagle. The names of the "Challenger," "Talisman," "Valdivia," "Hirondelle," "Princesse Alice," and other ships which have become famous in the annals of oceanography are boldly carved along the front. Two great groups of symbolic statuary flanking the immense window of the landing on the upper floor represent Truth unveiling the forces of the world to science, and Progress coming to the rescue of humanity. The roof of the central part of the building, eighty-seven meters above the sea, forms a meteorological observatory, and the main roof, five meters lower, forms an immense terrace, measuring a hundred meters by fifteen meters. The entrance hall, floored with mosaics representing the "Princesse Alice" at sea surrounded by trophies of deep-sea fish, contains the two great stone staircases leading to the upper floor, and unobtrusive doors leading to the stairs by which the director's room, library, laboratories, workshops, and aquarium on the lower floors are reached. It opens into a large square hall, lighted at night by an immense pendant representing a medusa, the lights in which are so disposed as to bring out the anatomy with extraordinary distinctness. Four smaller lights are incased in models of radiolaria very exactly reproduced.

A marble statue of the Prince in yachting costume, leaning on the rail of his yacht, occupies the center of the hall; this remarkably fine portrait, executed by M. D. Puech, was presented by a number of the sovereigns of Europe and other admirers of the Prince. Great doors to right and left open into the two wings of the building, each forming a lofty hall, lighted by windows along each side, which may be shaded or darkened as required. The western hall is at present fitted as a meeting room for functions, and here the ceremony of inauguration and the banquet took place. The platform at the west end is surmounted by an immense painting showing the slaty-blue ocean heaved into a long swell, with the white form of the "Princesse Alice" in the background. Electric lights in clusters, representing seaweeds and marine animals, hang from the roof, and the ceiling is frescoed with views of the sea and ships.

The eastern hall is occupied by a collection of oceanographic apparatus and specimens of marine zoology, arranged in a provisional way. The collection includes several whale skeletons, Arctic and Antarctic seals, models of fish, and a vast number of speci-



A FISH WITH TELESCOPIC EYES.

Front, side, and bottom views.

SOUNDING APPARATUS.

Collecting sand from the sea bottom. Open while descending.

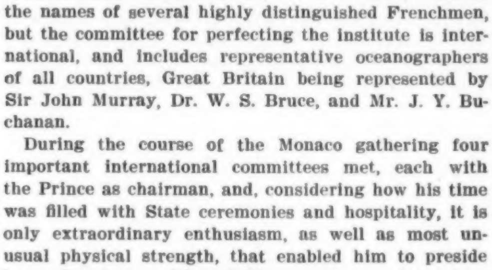
mens in preservatives. The labels are written in French, English, and German, and give sufficient details of the exhibits to enable a visitor to appreciate the remarkable character of many of the specimens.

On the upper floor, the central hall contains models of the "Princesse Alice I." and the "Princesse Alice II.," showing the arrangements for sounding and for working the zoological apparatus. There is a whaleboat exactly as used by the modern whaler, with the gun throwing the explosive harpoon at the bow, and the full equipment of harpoons, lines, and lances. The eastern hall on this floor will ultimately be devoted to physical oceanography and to deep-sea apparatus. Here there is a great collection of dredges, tow-nets, showing the various devices for opening and closing at a given depth, the deep-sea traps with which the Prince has revolutionized the method of obtaining animals from the greatest depths, and many other appliances, either as used or in the form of models. At present a part of the room is occupied by a collection of specimens illustrating marine industries, such as fishing, sponge gathering, collecting pearls, as well as the use of pearl shell, coral, tortoise shell, and similar products. The western hall is not yet arranged, but serves at present for classifying the various collections of molluska, bottom samples, etc., which are being dealt with.

The purpose of the museum is to have all the principal collections in duplicate, one set for exhibition, the other for purposes of study. The aquariums have already been utilized for the purpose of physiological and biological researches, and the little steam vessel "Eider" is available for students to familiarize themselves with the methods of practical oceanography. This little steamer, of twenty tons displacement and sixty horse-power, is fitted for working to a depth of 2,000 meters, and is being used for the detailed study of the portion of the Mediterranean in the immediate vicinity of the museum.

The Oceanographic Museum, under the direction of Dr. Richard, to whose admirable description of the building and the collections we are much indebted, is only one part of the Oceanographic Institute which the enlightened munificence of the Prince of Monaco has called into existence. With the object of arousing interest in scientific marine studies in France, the Prince started a series of lectures at the Sorbonne in 1903, and in 1906 he gave perpetuity to these courses of lectures by purchasing land which was much wanted for the extension of the university buildings and presenting it to the French nation, together with a building specially devoted to university instruction in oceanography. This building is now nearing completion, and will probably be opened in the present year, or at latest in 1911. Needless to say, the university and the French government accepted the gift with lively gratitude. Three professorships have been created in connection with it, M. A. Berget having the chair of physical oceanography, M. L. Joubin that of biological oceanography, and Dr. P. Portier that of the physiology of marine life. The administrative council, under the presidency of the Prince, includes the names of several highly distinguished Frenchmen, but the committee for perfecting the institute is international, and includes representative oceanographers of all countries, Great Britain being represented by Sir John Murray, Dr. W. S. Bruce, and Mr. J. Y. Buchanan.

During the course of the Monaco gathering four important international committees met, each with the Prince as chairman, and, considering how his time was filled with State ceremonies and hospitality, it is only extraordinary enthusiasm, as well as most unusual physical strength, that enabled him to preside hour after hour, with unfailing courtesy and constant tact, over proceedings conducted in three languages. The committees were those for perfecting the Oceanographic Institute; for research in the Mediterranean, in which we understand that the Italian govern-



FISH WITH REMARKABLE TACTILE ORGANS.

ment will take an active part; for research in the Atlantic, where international co-operation is hoped for, to be organized at a future meeting to be convened by the Oceanographical Institute in Paris; and, finally, for the preparation of a new edition of the Prince's bathymetrical chart of the oceans. It was decided in the new edition of this chart to suppress the indication of the nature of the bottom, which is often fallacious, to add contour lines and certain physical features on the land, and to revise the terminology.

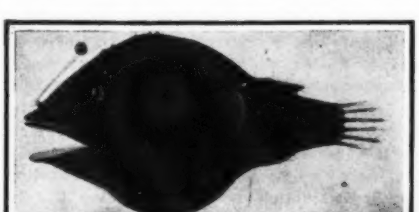
By his researches the Prince of Monaco has won for himself a place in the foremost rank of men of science, and by enshrining the results in the monumental buildings at Monaco and Paris he has invested his labors with permanent value for all time. His modesty and earnestness greatly impressed all those who took part in the proceedings here described, and, if a proof of this is demanded, it is enough to

PRINCE ALBERT OF MONACO IN THE UNIFORM OF THE ACADÉMIE DES SCIENCES OF PARIS.

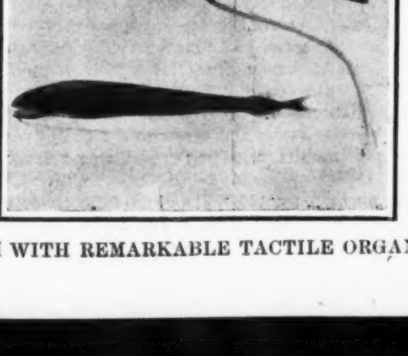
say that no one in authority mentioned the cost of the works, which is usually a prominent feature in the description of any benefactions.—Nature.

Crystals of the same substance vary greatly in their sensitiveness and in the treatment they should receive to obtain the best results for detecting electro-magnetic waves. It would appear that generally, to obtain the most sensitive results, there should be a very slight contact between the substances employed, but if a crystal can be found sensitive under a fairly hard pressure, the adjustment remains constant for a considerable time. According to Electrical Engineering, Mr. S. R. Drayton, the chief operator on the Trinidad government stations, finds that, of all the contact detectors at present tried, the silicon is the most reliable. Using no battery for ordinary working and a fairly hard pressure, this detector remains in adjustment for several weeks if it be short-circuited when transmitting, and a knock does not throw it out. To test if the detector be in adjustment, a fraction of a volt is switched on to the detector and telephone receiver in series; the click in the telephone tells whether the adjustment is correct.

The Baden State Railways after investigation, decided that the hearing of locomotive engineers is affected by vibrations of the engine communicated from the floor on which the men stand. To prevent this, cocoanut mats are to be provided both for engineman and fireman.



FISH WITH REMARKABLE TACTILE ORGANS.



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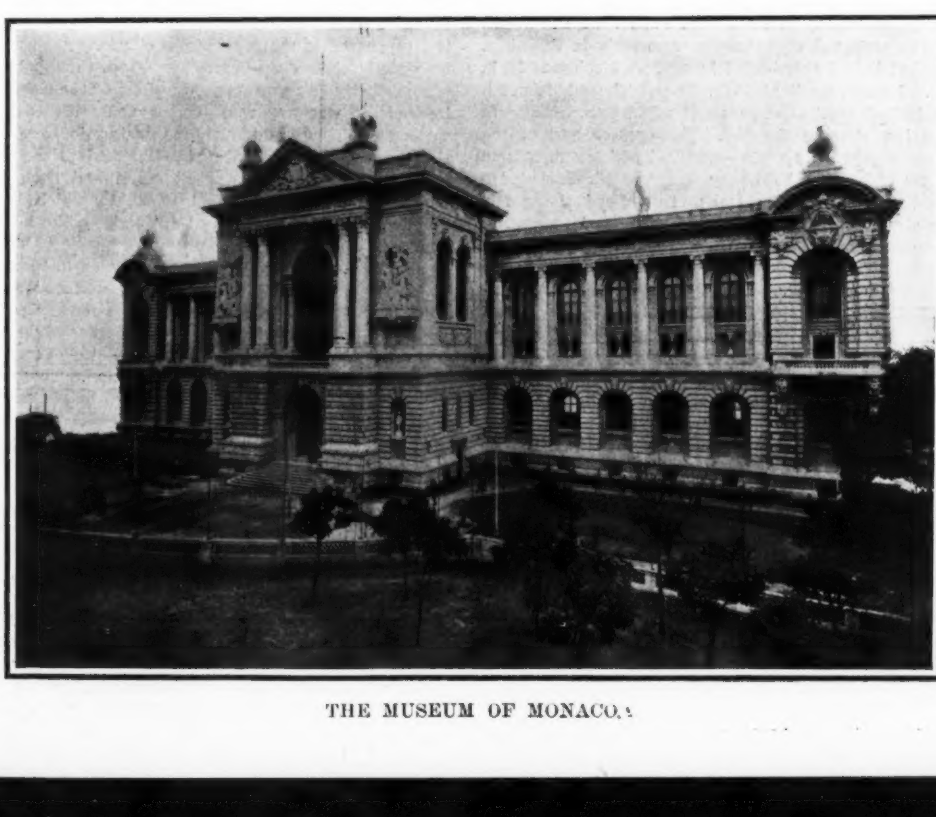


THE MUSEUM OF MONACO.

OBSERVATIONS MADE AT THE YERKES OBSERVATORY, 1902-1909.*

BY E. E. BARNARD OF THE YERKES OBSERVATORY.

ONE fact that is evident in the observations made at Yerkes Observatory is that the auroral arch varies greatly in size. For if we assume that it is the segment of a circle whose center is essentially stationary with respect to the earth, it must fluctuate as much as a diameter of itself in size. The arch sometimes extends half way to the celestial pole, and at other times its entire extent is beneath the horizon, as indicated by the streamers coming up from below the horizon.

Perhaps with the exception of the narrow ray—a degree in width and eighty degrees or more in length—which was seen rising from the west horizon on August 21st, 1903, no new phenomena have been seen.

The streamers which spring from the arch as a base, and which always have a decided lateral motion and last for a minute or so only, almost always move to the west. On several occasions, however, I have seen them divide the arch, with respect to their motion, so that the ones to the west moved west, and those to the east moved east. This is very rare. The motion is about 2 deg. in one minute (and not 2 minutes to the degree as I stated in Astrophysical Journal, 16, 143). I have wished to determine this motion more accurately, but we have had so few ray-producing auroras in late years, and the rays are so transient, that I have not been able to do so. It would be interesting to know if this motion is constant in a streamer and for all streamers.

The pulsating bright masses that usually appear in the northeast or northwest, but which are sometimes seen under the pole, are among the most interesting phenomena. They are sometimes present when there are no other evidences of an aurora.

In the auroras seen here there is comparatively little in the way of color. Referring again to the great aurora of April 16th, 1882, which I saw at Nashville, Tenn., there were magnificent brilliant crimson curtains in the west, and brilliant colors in other parts of the sky. But as seen from the Yerkes Observatory in the past ten or twelve years, there have not appeared any such striking colors. [This was written before the great aurora of October 18th, 1909.]

In some of the auroras seen here, there was a double arch—one several degrees higher than the other.

Extracts from my notes now follow, in continuation of those in the paper already referred to. Time of the ninetieth meridian (6 h. 0 m. slow of Greenwich mean time) is used throughout.†

1902.

November 23rd. 6 h. 30 m.: Faint auroral light in northern horizon. 7 h. 20 m.: Strong auroral arch, very low. Top of brightness half way to β Ursae Majoris. Dark under arch. No decided streamers, but bases of streamers moving to left. 8 h. 0 m.: The aurora had almost died out. There was still a feeble arch. 13 h. 0 m.: There was still a feeble glow.

1903.

October 30th. At 15 h. 0 m. a magnificent aurora was in progress. Mr. Sullivan says that there had been an arch, not conspicuous, from early in the night and that it had culminated in a great display at 15 h. 0 m. I first saw it at 15 h. 30 m. The whole north was full of great streamers and rapid pulsations were fluttering all over the sky. The greater part of the heavens—especially north—was full of hazy light, and masses of streaky brilliancy were conspicuous at different points. These streaks ran toward the north. The streamers seemed to converge toward the zenith where frequently masses of curved and irregular light appeared, fluctuating brightly and then drifting to the south. The fluctuations extended down to and below Orion. The streamers were broad—a few brilliant ones were narrow. They did not make much inclination to the horizon except to the northeast and northwest, and at their upper parts they seemed to diffuse toward the zenith, as if struck by a wind. For a certain height the streamers were straight, then they seemed to lose their force and become subject to drifting and irregularity. The ascending pulsations came from the north—not in arch form exactly. They would go to the zenith and beyond with extreme rapidity. There were several waves a second, but the irregular pulsations would last only 1/10 second. There was frequently a good deal of red and a tendency of the streamers to form curtains. But there was no definite arch—it was diffused and extended, 10 deg. or 15 deg. high. The sky, except overhead and north, was more or less covered with smeary clouds, especially from Orion south. Though these were illuminated when the light was strongest, they did not show the effect of the pulsations which seemed to pass by them in waves, showing that the pulsations were beyond them. There were a few streaky clouds in the north below the pole. I could not be positive that there was any of the auroral light this side of them. Several bright streamers were occulted by these clouds and everything seemed to be beyond the clouds. The activity extended nearly from east to west, through the north. At any one time the activity would be confined to either the northwest or northeast.

The streamers to the west of the pole moved west about 2 deg. a minute; those to the east moved to the east. I watched this carefully to see where the line of demarkation occurred. Usually here the summit of the arch is from 15 deg. to 20 deg. east of north, and one would suppose that there would be a stationary point for these streamers at the summit of the arch. Though there was no definite arch to go by I noticed that some of the streamers west of where the summit of the arch ought to be moved east as shown by the notes.

November 18th. 6 h. 0 m.: A slight aurora in the north. This rapidly brightened and formed an arch, not very dark beneath. A half hour later there were feeble efforts at streamers. There were two clouds of light at about 25 deg. altitude, one in the northwest, the other in the northeast. They would brighten up, then fade away.

1908.

May 25th. The display on this date was one of the most extraordinary that I have seen. The coincidence with a great electrical storm at this time was very singular, though it is probable that the two were not connected. At dark there were great banks of cumulus clouds in the west and northwest. These moved north and were alive with lightning—a most impressive sight.

A few minutes before 9 h. 0 m. a great number of narrow, but short, brightish strips like shreds of clouds appeared overhead. They formed a band across the sky from the north of west to the south of east through the zenith. The individual strips were moving west with great rapidity like low clouds driven by a heavy wind and appeared to be only a few hundred feet distant. From their luminosity it was at once evident that they were of an auroral nature. At this time there were several great streamers in the north, but the northern horizon was covered with clouds. It was therefore not certain that any arch existed. In some ten or fifteen minutes the strips overhead, which were inclined sharply to the general direction of the band and which were ½ deg. wide and 10 deg. ± long and had been moving westerly, had now blended into a beautiful, soft, but bright, band of cometary-looking light. This band was 10 deg. wide and had its south edge in the zenith. It extended from the east by south horizon (in clouds) to the west by north where it disappeared in the great storm clouds. The sky was beautifully clear elsewhere. The band, though bright, was perfectly transparent to the light of the stars. At its ends it was apparently connected with two narrower and sharper and brighter cometary-looking strips that were perhaps connected with the horizon. The appearance was as if a great scroll had been flung across the sky and the end sticks to which it was attached had been dropped at an angle to the horizon. These end strips were at an angle of some 20 deg. to the vertical, inclining to the south. At 9 h. 20 m., between the great arch and the pole, another band of short strips some 3 deg. apart appeared. Near the meridian these strips pointed to the pole, while away from the meridian they pointed to the northwest. They apparently had no decided motion. These soon disappeared. The great band remained bright and uniform. It however was drifting very slowly to the south, and at 9 h. 30 m. it passed through the zenith. Then a parallel strip formed beside it and a few degrees north, which broke into short narrow strips pointing (overhead) toward the pole, but, beyond the zenith, to the northwest. These strips were longer and narrower away from overhead. They were not so well developed in the east. There was little or no motion in these. They fluctuated rather slowly in light and presently disappeared. Shortly after 10 h. the great band broke up into short strips—at a sharp angle to its length—which had a rapid westward motion. Finally the band faded out overhead, the two ends becoming thus disconnected. The upper end of the west section drifted south so that the two would not connect if continued. This kept very bright and became narrow, while the east portion split laterally into several parts. These shattered into short strips 10 deg. or 15 deg. long which had a quick, short motion northerly. There were apparently other strips nearer to us that moved rapidly over the first ones. Their visible existence seemed to extend over about 10 deg. of motion. About 10 h. this easterly portion drifted overhead in a fragmentary form—frequently in this appeared the moving forms. At 10 h. 15 m. or 10 h. 20 m., at the time the masses of light in the zenith were fading out, the sky was blotted out by the storm clouds.

During all this time all over the west and northwest there was a magnificent and rapid electrical display in the clouds—so bright that it frequently blotted out everything else. Just before the storm closed in, a great, black, broad path of clouds came rapidly from the storm clouds in the west. This was perfectly straight at the edges and stretched from the northern sky to the southern horizons and was uniformly 15 deg. or 20 deg. broad with clear sky on each side. It swept overhead very rapidly—black, opaque, and sharply defined. As it passed I could see a few irregularities in it. These were moving very rapidly along its length to the north, while the whole extent of the band itself moved rapidly a little to the north of east. When finally low in the east this object looked like an irregular strip of cloud. It was first seen near the west horizon under the great storm clouds and was then very black and sharply defined. There was no lightning in this band. I doubt if it had anything to do with the aurora, but its singular appearance and motion at this time were strange enough for record.

At 9 h. 15 m. the great zone of light stretched directly through the zenith. At the east it would strike the horizon 10 deg. south of east. In the west it passed 10 deg. north of Venus. Roughly it was perpendicular to the magnetic meridian. It was nearly 10 deg. broad—bright and transparent. Its light strongly reminded one of that of a comet.

There were some newspaper accounts of this singular phenomenon, which seemed to have been seen at various other places. In general these accounts were of no value in locating the position in the sky. One newspaper had a long editorial on the subject and associated it with the zodiacal light, giving a lengthy history of the latter object. Of course there was no connection between the two phenomena.

According to Dr. Walter L. Rankin, of Carroll College, Waukesha, Wis., who observed the band, its summit was at an altitude of 70 deg. and south of the zenith. Waukesha is 29 miles north and 13 miles east of the Yerkes Observatory. Taking into account the inclination of the band to the east-and-west line, his observation would make it about 140 miles high.

A description in the Northfield (Minn.) News says: "The peculiar aurora was in the shape of a long searchlight, like a path running east and west, from 7 deg. to 10 deg. wide, and at an elevation of 70 deg. above the southern horizon." This would place it some 4 or 5 times as high as Mr. Rankin's observations. It seems quite probable that it was, in its later stages, several hundred miles above the earth's surface. The times were not given in any of the observations, and as it had a motion, southerly, of over 5 deg. while under observation here, it is probable that the results given for its height are not very trustworthy.

I have thought that the remarkable nature of this display would warrant a full description, as some of the features were to me unique.

In Science for July 10th, 1908 (28, 51), an account is given of what was apparently a similar display of the aurora on March 27th, 1908, by Wilmot E. Ellis, of Fort Terry, N. Y. His confusion of this phenomenon with the zodiacal light is unwarranted. The zodiacal light never exhibits any such phenomena as the above. Indeed it does not show any marked changes which cannot be readily accounted for by the position of the observer or the atmospheric conditions at the time. The phenomenon of March 27th was purely auroral.

The night of March 27th was cloudy here, with a vivid electric storm and heavy rain the first part.

May 26th. 11 h. 20 m.: There was a large, luminous, elongated cloud in the low northwest, whose light fluctuated rapidly. The entire sky was covered with patches and smears of luminous haze which I am sure were auroral. The night was strangely lumi-

* Abstracted from the Astrophysical Journal.

† Lack of space prevents our publishing Prof. Barnard's notes in full, Ed. of SCIENTIFIC AMERICAN SUPPLEMENT.

nous. The sky was apparently covered with a luminous patchy haze. In places it was streaky and sometimes long streams of it were seen. Some of these were nearly as bright as the brightest part of the Milky Way. With the lights out in the dome the windows looked as bright as if the sky were moonlit. With the exception of the pulsating cloud in the low northwest there were no other certain evidences of an aurora. But the unusual brightness of the sky and the patches and strips of luminous haze suggested that a strange auroral effect was on hand.

September 29th. 7 h. 10 m.: Brilliant aurora seen through breaks in clouds, all over the north, northeast, and northwest. Some effort at streamers. 11 h. 10 m.: The aurora had been very active with streamers and fluctuating patches of light. At about 8 h. 30 m. it was very brilliant. The sky in the north looked like daylight. The illumination extended a great distance east and west and the whole northern sky as high as the pole was bright, but there was not much activity. It got less bright and broke up into patches and became very active with streamers that reached higher than the pole. If any arch existed it was lost in the broken clouds which covered the sky more or less all the time. Patches or areas of light would ascend to great altitudes and then die out. At this time (11 h. 10 m.) the light had almost died out, but there were some streamers. The sky was pretty well covered with clouds. 12 h. 0 m.: Some streamers and broken masses. Clouds. 13 h. 0 m.: Less bright. Clouds.

1909.

January 1st. 15 h. 40 m.: Streamers from behind clouds in the north—the first aurora I had seen for a long time. It seemed to be quite active.

January 24th. 12 h. 0 m.: A bright aurora all along the northern horizon among broken clouds. Not active. First saw it at 11 h. 45 m.—it was not visible an hour earlier. 13 h. 0 m.: Aurora visible as a bright streak along the horizon under the clouds. 14 h. 0 m.: Same as before. 15 h. 0 m.: Was still visible under the clouds.

January 25th. 10 h. 0 m.: Auroral glow in the low north. 10 h. 30 m.: Only feebly seen. 12 h. 40 m.: It was active. If any arch existed it was below the horizon. There was not even a glow along the horizon, but the streamers and sheets of light rose nearly half way to the pole. They were not bright.

January 26th. 15 h. 0 m.: Faint aurora, with very low arch. There was none an hour earlier. 16 h. 45 m.: Arch very low, 3 deg. high. No streamers Bright changing patches in the arch.

February 21st. 9 h. 30 m.: Very low arch. Dark part 3 deg. high; top of bright arch 5 deg. to 6 deg. 10 h. 30 m.: There was an auroral arch at the horizon, the dark part having sunk below. 16 h. 0 m.: The aurora had died down. There were attempts at streamers for a while. 16 h. 30 m.: It was very bright again. Arch almost on the horizon—so low that there was scarcely any dark beneath.

March 19th. There did not seem to be any aurora until 8 h. 45 m., when a long streamer appeared east of north, which moved west. At this time there was only the feeblest glow and no arch. It became more active later and the glow was stronger. 9 h. 15 m.: Many streamers, but no arch. 9 h. 45 m.: Great deal of glow and streamers some of which reached nearly to the pole. 11 h. 0 m.: The aurora was dead. 12 h. 30 m.: Nothing visible. If there was any arch on this night it was below the horizon.

March 20th. 12 h. 45 m.: Considerable auroral light and a few streamers. (R) says "all night."

March 21st. 7 h. 50 m.: A feeble auroral glow.

March 28th. 11 h. 30 m.: Splendid aurora; curtains; ascending pulsations. The curtain waves went east. At first the narrow streams went west. 12 h. 20 m.: It was not active at this time, but the arch was very bright. It extended very far east. 12 h. 25 m.: It was almost dead. Same at 13 h. 20 m.: This aurora was the finest example of curtain effect that I have seen here. They were white and some of them bluish white. These curtains moved rather rapidly east, while the slender streamers that made their appearance previous to the curtains moved west all along the arch. There were rapid ascending pulsations, and a broken second arch above the main arch. 15 h. 40 m.: Aurora active again. No definite arch, but masses resembling bright cumulus clouds from which sheets of faint light were going up. The aurora was more or less active until daylight. It would frequently almost die out, then brighten up again. Its most active period was before midnight—about 11 h. 30 m.

Observer absent from April 19th to April 30th. Mr. Lee reported that there was an aurora with low arch and some streamers at about 15 h. on April 25th. It was not bright.

October 18th. A magnificent aurora was visible at 7 h. I first saw it at 7 h. 45 m. At this time all the northern sky below the pole was covered with great masses of light, with apparently a double arch. It was very active at 8 h. 0 m., with streamers and broken masses of light. At 8 h. 25 m. there were great masses of light far in the northeast which drifted slowly to the west and rose higher until the sky to the zenith and as far as Saturn was covered with them. At 8 h. 30 m. there were rapid ascending pulsations. These ascending waves seemed to bring out and illuminate large areas of matter all over the north, that were drifting westward. At 8 h. 35 m. the arch had again formed and streamers (with dark intervals between them) all along its periphery. A very fine sight. Beautiful slender streamers ascended as high as Polaris. Several of those to the left moved rapidly to the right, or eastward. These apparently passed others going west. To the west the streamers were reddish, but the general display was of a bright yellow. Many of the slender streamers shot higher than Polaris. At 8 h. 45 m. all the northern sky was covered with tufty masses of light which were elongated vertically. At 9 h. 5 m. a thin bright arch extended to an altitude of 10 deg. At 9 h. 45 m. there was a fine and bright arch at an altitude of 14 deg., with bright masses far toward the east apparently separated from the rest of the aurora. α Ursae Majoris was in the upper edge of the bright arch, which was black beneath only toward the east, the rest being luminous below the arch. The arch was very perfect but not active. At 9 h. 58 m. rapid waves were ascending all along the arch and pulsating diffusions of luminosity all over the heavens north of the zenith, but the arch was not active, no streamers. At 10 h. 15 m. the arch became active to the west. It had risen slowly and was then 17 deg. high, but it was not dark underneath. Waves of faint light were ascending everywhere in the north, to the zenith. α Ursae Majoris was at this time in the lower part of the arch. There were masses of light in the east free of the arch which was very large and wide, extending along the horizon for 100 deg. At 10 h. 22 m. there were beautiful curtains in the west, springing from the arch and extending to great altitudes. These moved rapidly to the east. Their bases were bluish white with strong prismatic colors. It was a splendid sight! Beginning at the west these curtain-forming streamers would burst out along the summit of the arch, which was very perfectly formed, one at a time in rapid succession ascending to great altitudes. Thus, the arch was broken to pieces. The whole system of moving curtains moved bodily to the east. This greatest display lasted only a minute or two, and was one of the grandest I have ever seen. Then everything broke up into masses of light all over the north to the zenith. During this display there was a great curtain-like mass below the middle of the arch which nearly touched the horizon and moved to the left. 10 h. 30 m.: Great streamers everywhere in the north reaching nearly to the zenith; very active. Great masses of light and fragments of streamers all over the north, but no arch. At 10 h. 35 m. rapidly ascending waves were rising everywhere in the north with great masses of light all over the northern sky extending to the east point. 10 h. 47 m.: Fantastic masses dancing all over the northern heavens to the zenith, which seemed to be due to rapid pulsations of light, which, as they passed, momentarily illuminated irregular masses of matter that were changing form slowly and moving to the west. 10 h. 52 m.: The rapid pulsations seemed to have ceased, but there were still great masses of light all over the north to the zenith, which would slowly brighten and fade. At this time the arch was again forming. At 10 h. 55 m. the arch was very black below and only half as high as before. Ascending pulsations and bright masses all over the north to the zenith. The sky was more or less luminous everywhere except in the far south. The pulsations were still rising at 11 h. 5 m. and the arch was broken, but at 11 h. 35 m. it was very strong again and very dark underneath. Ten minutes later it was broken again by masses of light and some streamers. At 13 h. 0 m. the arch was still pretty strong, but not active. At 16 h. 20 m. it was all dead except some pulsating masses of light near the northern horizon. 17 h. 0 m.: The same.

This was one of the finest auroras I have seen here. Especially was the display of curtains splendid at 10 h. 22 m. I have never before seen the brilliant prismatic color effects which burst out on the forming of the curtains. I was strongly impressed with the resemblance of some of the streamers to comets' tails, etc. They would shoot up, sometimes very slender, and then diffuse into broad wavy masses moving west. The general motion was west except the curtains mentioned and the few streamers that moved east, and the pulsations which were vertical. At times great areas of feeble illumination would appear for a second or so all over the north. Sometimes these illuminations were very bright. They appeared like great areas of bright haze. Altogether the display was one of the most brilliant I have ever seen.

REMARKS ON THE RESULTS OF THE OBSERVATIONS.

In reading the accounts given in Nature and the Astronomische Nachrichten of the luminous nights seen in England and on the Continent about the first of July, 1908, by Denning and others, I have thought that the phenomenon of the luminous night of May 26th, 1908 (and of other dates), was of a similar nature to those described by the various observers in July.

In Nature for September 30th, 1909 (81, 395), Dr. Chree gives an account of a great magnetic storm, recorded at Kew, which "commenced suddenly at about 11 h. 43 m. A. M." on September 25th: "The storm was of comparatively short duration, no movements of any great size being recorded after 8 h. 30 m. P. M. on September 25th, and by 1 A. M. on September 26th little trace of the disturbance was left."

This same storm badly interfered with telegraphic operations all over the United States on September 25th. According to the newspapers it was very active between 6 and 9 A. M. I observed all night on the 24th, closing observations just before 17 h. or 5 A. M. of the 25th, or 11 A. M. at Greenwich. I looked out for any aurora just before daylight, but there was none, nor had there been any during the night which would be bright enough to be seen in moonlight. As recorded above in my notes, there was an aurora on the 25th at 15 h. 30 m. I had suspected one earlier in the night, but it was uncertain on account of the moon.

For a valuable account of the condition of the solar activities about the period of this great disturbance, see an article by Prof. Frederick Slocum in the Astrophysical Journal for January, 1910.

For some years, I have had in my mind a scheme for systematic observations of the aurora, but for various reasons it has not been possible to carry it out, as it would require the permanent residence of one observer some miles north of here. The scheme would be to have someone, say a resident of some place ten or twenty miles north of the Yerkes Observatory, who would be familiar enough with the stars to locate an object with the naked eye by them, or who had an instrument for the determination of the altitude and azimuth of such objects. Suppose such an observer to be connected with the Yerkes Observatory by telephone. Upon the appearance of any striking auroral phenomenon, such as the moving, fluctuating clouds, simultaneous observations could be made of these that would give their true altitude above the earth. As they sometimes remain visible for upward of an hour, these observations would show if they varied their height and would also give accurately their real velocity with respect to the earth. The actual elevation of the arch could thus be determined also, and various other phenomena of importance. A simple instrument made of wood, such as I have described in the Astrophysical Journal, 16, 144, 1902, would give the position of the object with sufficient exactness for the purpose—especially if pointings were also made on some known star at the time. Observations of this kind would quite definitely show whether different observers at a distance really see the same thing or that each person sees his own aurora, as in the case of the rainbow, as has been suggested by some writers. The fluctuating clouds and their motion would alone perhaps contradict this theory.

In the present paper, I have gone somewhat into detail in the accounts of the auroral displays here. This has been done because it has appeared to me that in general the references to an aurora usually are wanting in details and leave doubt as to what kind of aurora had been present. It would seem that there may be different kinds of auroras due to different causes or to modifications of some one cause. If so, these should be distinguished from each other. For instance, sometimes the fluctuating clouds have appeared when there was no other evidence of an aurora. At other times they have been present during an ordinary aurora. These clouds therefore would seem to depend on different conditions from the regular aurora. At times these conditions alone are present, at other times they combine with those necessary for the production of the ordinary aurora. Certainly the conditions must have been different that produced the great band of May 26th, 1908. So also must those that produced the luminous nights mentioned in these observations. A classification of the various kinds of auroras would therefore be valuable. It is with this idea in view that I have dealt more extensively with some of the displays of the past ten years.

Table of Auroras Observed from 1897 to 1909 Inclusive.

	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	No. by Months.
January	.	2	1	..	..	..	..	..	..	..	..	2	4	9
February	.	..	2	..	..	..	..	..	2	2	12	..	1	19
March	1	6	..	..	..	..	.	..	2	1	3	2	4	19
April	1	..	..	1	..	1	..	2	..	..	2	1	1	9
May	..	1	3	1	..	1	..	..	..	1	1	5	3	16
June		..	3	..	..	..	..	2	..	1	..	2	1	9
July	1		1	..	..	..			..	..		2	1	5
August	2	1	1	..	..	..	1	..	..	1	1	7	3	17
September	.	4	4	1	..	..	4		1	2	1	5	3	25
October	1	1	..	..	..	..	1	3	..	1	3	7	..	17
November		2	1	..	1	..	4	3	1	..	1	6	..	19
December	2	1	..	..	..	..	1	..	..	..	1	1	..	6
No by Years	8	18	16	3	1	2	11	10	6	9	25	40	21	170 = total.

The recorded times are important, especially in case of the spasms of activity in the large auroras. It would be interesting to compare these with the magnetic records to see if any special disturbances show at these times on the instrumental records.

I will not here go into any discussion of the connection between solar disturbances (as indicated alone by great sun-spots) and the aurora. This does not lie within my province. It may not be out of the way to state, however, that such a connection does not at present seem to be clearly established in all cases. I have within the past ten years or so frequently noted solar spots so large as to be visible to the unaided eye. These have not always been closely associated with auroral displays. A most striking instance of this kind was shown in the case of a large naked-eye sunspot on and about December 29th, 1909. A careful record on every clear night about this time failed to show any evidence of aurora. Indeed this prolonged absence of auroras (up to the latter part of January, 1910) would have been noticeable without the incentive of the large sun-spot to look for them.

I have thought that it might be interesting to see if any months are more abundant in auroras here than others. For this purpose Miss Calvert has prepared from my observations the foregoing table.

This table gives the number of auroras seen in each month from 1897 to the end of 1909. The last vertical column gives the entire number for each month during this interval. The horizontal column at the bottom of the table gives the frequency for the various years. September has been especially prolific, but September is a season of clear skies. February also stands high, but this high grade is dependent on the year 1907. July and December stand especially low. There seems to have been a minimum of auroras from 1900 to 1902. The observer was absent on the eclipse expedition to Sumatra from the first of January to the last of July of 1901. The year 1908 gives the highest record of all—auroras on forty nights. But the summer and fall of 1908 were remarkably free from clouds. The combination of 1907, 1908, and 1909 would seem, however, to indicate a maximum in which we are now placed or which we have just passed through.

It is evident, however, that to determine accurately the frequency of auroras here in the past thirteen years it would be necessary to compare the observations with the various meteorological conditions that have prevailed in that time. I have not the leisure at present to undertake this work, and so the results must stand as they are.

COMETS' TAILS AND THE EARTH.

THE EARTH'S PASSAGE THROUGH THE TAIL OF A COMET 804 YEARS AGO.

BY WILHELM KREBS.

On May 18th, at 9 P. M. Eastern Standard Time, Halley's comet will pass directly between the sun and the earth, and its tail will sweep over and envelop the earth. This remarkable conjunction, which may cause great perturbation in the orbit of the comet, and may also furnish data from which the comet's mass can be determined, will be visible only from that part of the earth that is then turned toward the sun, i. e., the Pacific region, and any effect produced on the earth by its passage through the comet's tail will be most conspicuous in the same region. The American Astronomical Society and the American Academy of Science have sent a joint expedition to the Hawaiian Islands, for the purpose of observing the conjunction and of photographing the comet when it is at and near its perihelion and its tail is most strongly developed.

There is no reason to fear that we shall all be killed by the poisonous gases of the comet's tail, although Camille Flammarion has endeavored to revive this specter, which arose in 1832, when a collision between a comet and the earth was predicted.

The only certainly proved passage of the earth through a comet's tail occurred on June 26th, 1819.* No effects due to the passage were detected, but the comet was a small one, although it showed a tail of considerable length when it emerged from the sun's radiance on the last night of June, the only night on which it was generally visible to the naked eye. It was predicted that the earth would pass through the tail of a very large comet in the latter part of June, 1861, but the calculations were afterward shown to be erroneous.

In this connection it is interesting to note that a miracle book of the 16th century mentions the passage of a very large comet between the earth and the sun, and a phenomenon apparently connected therewith. The events are alleged to have occurred in 1106. The book, which appeared in 1557, under the title: "Prodigiorum et Ostentorum Chronicon," was written by Conradus Lycosthenes. The most probable translation of the rather obscure Latin passage runs about as follows:

"On the 5th of February a comet was seen in the sky, in the daytime, from the third to the ninth hour, about an ell distant from the sun. Soon afterward on the same day, at Bari in Italy, stars were seen by daylight, now appearing to race with each other across the sky, now seeming to fall toward the earth."

THE METEORIC SHOWER SEEN BY DAYLIGHT AFTER THE PASSAGE OF THE COMET.

THE PASSAGE OF THE GREAT COMET OF 1106 BETWEEN THE EARTH AND THE SUN.

From a Book of Wonders, published in Germany in the 16th century.

In short, we are told that on February 5th, 1106, a comet was seen near the sun, in broad daylight, and that the still rarer phenomenon of a daytime meteoric shower was observed soon afterward.

This great comet of February, 1106, was one of the most striking apparitions in the history of astronomy. It was seen, not only in Europe, but also in Palestine and China. Later in the month, according to Maedler, its head was in the constellation Pisces, while its tail stretched out toward Orion and covered a large part of the sky. The head was not very bright. Upon this comet Whiston founded his system of cosmogony.

Newton, in 1680, predicted the return of this great comet about the year 2255. This was the first computation of the orbit of a periodic comet, and it served Halley as a model when, two years later and at Newton's suggestion, he calculated the orbit and periodic time of the comet which has since borne his name. But, while Halley's calculations were confirmed by the observed return of his comet, only 17 years after his death, those of Newton cannot, in the most favorable event, be confirmed until the year 2255. The accuracy of Newton's result has, furthermore, been made very questionable by Encke's re-calculation.

The fact of most importance for our purpose, that has been recorded concerning the great comet of 1106, is that it remained not only visible but brilliant for more than two weeks after its passage between the earth and the sun on February 5th, and did not begin to wane and dwindle until February 20th.

Hence the effect produced even on the light and tenuous comet by the conjunction was not serious, and the influence exerted on the massive globe of the earth, protected by its atmospheric mantle, must have been very much smaller. The only apparent consequence was the fall of an unusually brilliant meteoric shower.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Umschau.

ABOUT MOUNT ETNA.

THE reports as to the numerous craters which, says English Mechanic and World of Science, are active at Etna are what might be expected, for one of the peculiarities of Etna is the extraordinary number of minor cones—estimated by some at 200—which are scattered over its sides. The main crater, according to Mr. G. F. Rodwell, who made an ascent in 1877, is a vast abyss nearly 1,000 feet in depth, shut in by precipitous sides. Its dimensions vary, but it was then between two and three miles in circumference. Sometimes it is nearly full of lava; at other times it appears to be bottomless.

One of the most famous eruptions was that of 1669, an account of which was written by the Earl of Winchilsea, one-time British Ambassador at Constantinople, who was an eye-witness of the phenomenon. He says the eruption took the form of "an inundation of fire, a flood of fire cinders and burning stones, burning with that rage as to advance into the sea 600 yards, and that to a mile in breadth, and that which did augment my admiration was to see in the sea this matter, like rugged rocks, burning in four-fathom water." In forty days, Lord Winchilsea went on to say, the eruption destroyed the habitations of 27,000 persons, made two hills, one 1,000 paces high and the other four miles in compass, while of 20,000 persons inhabiting Catania, only 3,000 remained.

According to Baron von Waltershausen, who has supplied the most exhaustive description of Mount Etna, no fewer than 300,000 people live on its sides. Thus, with an area rather larger than that of Bedfordshire (462 square miles), it has more than double the population.

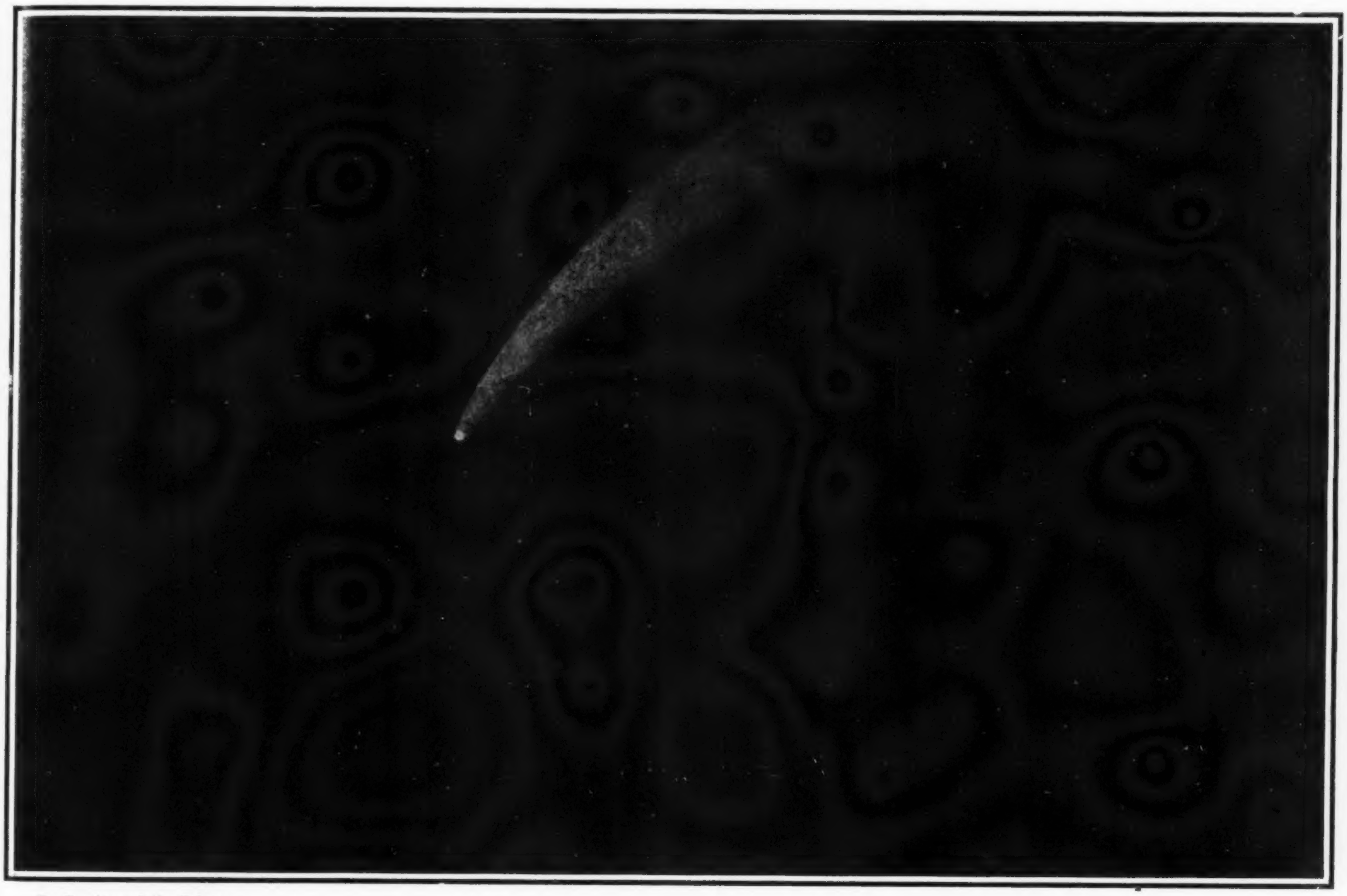
The surface of the mountain consists, roughly, of three different regions—namely, the cultivated region at the base, yielding all the ordinary products of Sicily, such as vines, corn, olives, pistachio nuts, mulberries, oranges, lemons, figs, and other fruit trees. Above, from the height of 2,000 feet to an approximate height of 6,300 feet, extends the woody region, comprising fourteen separate forests, some abounding with oak, beech, pine, and poplar, others with chestnut, ilex, and cork tree.

The desert region lies between the limit of 6,300 feet and the summit (about 10,867 feet). It occupies an area of about ten square miles, and consists of a dreary waste of black sand, scoriæ, ashes, and masses of ejected lava. In autumn, winter, and spring it remains permanently covered with snow, and even in the height of summer snow may be found in rifts near the summit.

Sharpening the bits of the 300 rock drills used in the Calumet and Hecla mines is done automatically, the only labor being to put them on a conveyor at the outset. They are heated, sharpened, upset, fluted, brought back to exact size and tempered by machines, passing from one to the other mechanically. The plant is driven electrically, but the sharpening and upsetting are performed by compressed air hammers, and the fluting is done by an 800-pound steam hammer. With all drills running about 4,000 bits must be sharpened every day.

CHARLES DICKENS AND DONATI'S COMET.

"CHIPS FROM THE COMET."



By Courtesy of the Sphere.

This picture shows the greatest comet of the nineteenth century as it appeared to an English observer, who was an exhibitor at the Royal Academy. At the time when the painting was made the tail was sweeping over the bright star, Arcturus, which shone undiminished through the nebulous plume, the extremity of which reached the stars forming the handle of the Dipper (Ursa Major). To the left were the stars of Libra and to the right the stars of Leo. The comet was discovered by Donati at Florence on June 2nd, 1858, as a small telescopic object approaching the sun. Not for nearly three months did it become visible to the naked eye, but thence, right up to the time of its perihelion passage at the end of September, it grew rapidly in brightness until its starlike nucleus was as bright as the Pole Star. During September its tail was directed nearly towards the earth, and though bright was seen so much foreshortened that its effect was greatly marred; but as the comet passed perihelion and began to recede from the sun its path, by good fortune, was most favorably placed. The splendid bright tail then lay almost at right angles to the line of sight, and its whole length was for the first time displayed. Other comets have had longer tails, though this was more than 40,000,000 miles long, but none have surpassed Donati's comet in beauty. The main tail, the curved plume, was of the type shown afterwards by the spectroscope to consist of hydrocarbons; the thin, straight streamers are of the hydrogen type. Evaporated apparently from the nucleus of the comet by the heat of the sun, the particles of the tail are repelled from the sun by some force whose nature is still problematical and driven backwards from it with enormous speed.

DONATI'S GREAT COMET OF 1858.

WHEN Charles Dickens was the Editor of Household Words, there appeared in its pages for the issue of November, 1858, an article on Donati's Great Comet of 1858, entitled "Chips from the Comet." Whether or not this article was written by Dickens, it is difficult to state, but there is internal evidence of touches of his. The article follows:

From first to last, Donati's comet has thrown off more chips than people in general dream of, some of them very considerable ones. It has turned out to be a sort of celestial egg inclosed in a multitude of shells, which it got rid of as it approached the sun, like the traveler who cast aside his cloak under the mild persuasion of Phoebus Apollo; although Boreas had in vain endeavored to force it from him. Donati's comet exhibited one very remarkable phenomenon; it formed successively, around its central nebulosity, a series of luminous envelopes distant and distinct from each other, till they attained the number of eight at least; so that the comet seemed to be a never-ending nest of boxes of light.

Similar phenomena were observed by the first Herschel, and by Olbers in the grand comet of eighteen hundred and eleven. What physical condition of the star itself can be conjoined with such a continual casting of luminous skins, it is difficult for us to imagine in our wildest reveries. It would seem at least to betoken the impossibility that the hairy wanderer (*cometa*, derived from *kóun*, *coma*, a head or hair) should be the dwelling-place of any animated beings whatever. And yet, if we had never seen fish, nor water insects and mollusks, and had no further experience of water than that it drowned us whenever we fell into it and remained submerged, we might be tempted to say, that it was impossible for organized creatures to exist in water. Therefore, we must hesitate before deciding that even Donati's comet may not have its inhabitants, whom we may suppose to wake up and dance, like a swarm of gnats, at their approach to the sun, and to fall again into torpid lethargy when their long, long winter recommences.

That the existence of such cometarians is improbable, though not impossible, may be concluded from the observations and reasonings of Monsieur Brento. That learned astronomer remarked, that the brightness of Donati's comet was less than that of the atmosphere soon after sunset; which is less than that of the same atmosphere during day-time, which is less than that of the moon when she is visible in broad day; which is nearly equal to that of a little white cloud of the same angular diameter. Yet the comet was fully exposed to the blazing sunshine, and was illuminated by its rays about three times as much as we are. If we combine these indications with the immense depth of the comet which our visual rays traversed—an ocean of luminous matter millions of miles deep in the portion of the tail comparatively near to the nucleus—some idea may be conceived of the excessive rarity of the vapor or dust of which the heavenly body is formed.

The curiosity of the public was greatly excited to trace the development of the tail; but that development may be easily understood as soon as the excessive rarity of the comet's ponderable matter is taken into account. Whether dust or vapor, it is believed to be in any case an incoherent assemblage of atoms; and, moreover, that every ponderable atom of the tail follows its own proper orbit, independently of the orbits of the neighboring atoms. Now, if you throw into the air a shovelful of sand, it requires particular care and especial address to make the sand fly all in one mass, like a stone; it is a necessary condition of such a feat that the grains of sand, when they leave the shovel should all have equal and parallel velocities. If this condition be not fulfilled, every grain follows its own course separately. These courses diverge and separate, and the shovelful of sand spreads itself out into diverse forms. It is like the contents of a gun-barrel laden with small shot. The charge rarely forms a ball or flies in one compact mass; every single shot follows its own independent trajectory, and the charge spreads.

Besides this, the observations and calculations m on the course of the comet's nucleus, indicate t it, the nucleus, has an elliptical orbit with a pe of about twenty-one centuries. But all the particles which may have acquired even moderate accelerations, would necessarily assume hyperbolical orbits. An ellipse, or oval, is a curved line which returns into itself, like a circle, and might equally, like it, be taken for an emblem of eternity. A hyperbola is a sort of oval with one end burst open and the lines imperfectly straightened, so that there is no return into itself. It has a curve which may be roughly compared to a pair of sugar tongs with never-ending legs, distended by a large lump of sugar; for hyperbolous legs may be lengthened, or may extend, infinitely. Consequently, if any cause breaks open a comet's elliptical orbit, or the elliptical orbit of any of its non-coherent portions so as to pull and wring it into a hyperbola, there is no more return possible for that comet, or that portion of a comet. Now, when we remember the immense length of a comet, it is clear that the perturbations of the planets, acting unequally on the different portions of a comet, in consequence of their unequal distances, are certainly sufficient to give them diverging orbits. The materials of the tail are thus dissipated forever, or nearly so. Therefore, could

we even live one-and-twenty centuries, like Donati's comet, we ne'er shall look upon its like again; even if we saw its professed self. Finally, Donati's comet appears to have experienced, at its perihelion, powerful physical actions from the solar heat. These actions must have accelerated the particles of one-half of the nucleus, and retarded those of the other half; so that the former would take orbits of longer period, or even hyperbolical orbits, whilst the period of the latter would be shortened. Donati (who is about to publish drawings of his comet in its different phases) himself says, that there can be no doubt that the sun successively detached matter from the comet's head, which matter was afterwards dispersed by taking its departure from the nucleus, to constitute the hairy portion of the tail of the star. A comet would thus be a magnificent fire-work, which would burn itself out and become dissipated by the very act of its display.

From the motion of comets which describe hyperbolical orbits, Monsieur Brento ingeniously calculates the direction and the greatness of the sun's motion of translation through space. It would appear that, at the present moment, the sun's velocity of translation, instead of being great and proportional to the magnitude and importance of that heavenly body, is scarcely equal to the sixth of that of the earth in her orbit.

Prof. Govi, one of Donati's friends, ascertained, in the first place, the polarization of the comet's light, confirming what Arago had observed in eighteen hundred and thirty-five in Halley's comet; secondly, he determined the position of the plane of polarization of this light, whose plane coincided sensibly with the axis of the tail. This coincidence continued to exist till the tenth of October; after which date bad weather prevented the comet's being observed for some time. This position of the plane of polarization in reference to the position of the sun, removes all doubt as to the source of at least the most considerable portion of the light with which the comet shone—namely, that it was derived from the sun.

These are not the only nor the least considerable chips that have fallen from the comet and its predecessors. Our readers will recollect that the existence of the ether (if demonstrated) was demonstrated by a comet. It had been previously rendered probable, and has since been confirmed, by calculations based on the undulatory theory of light as a hypothesis, and by their accordance with the actual phenomena. The discovery of the phenomena of interference, in which two lights, by mingling with each other, reciprocally annul each other's effects; that of the polarization of light, which renders its rays susceptible of being reflected without being refracted in a certain plane for that particular ray, and susceptible, on the other hand, of refraction and not of reflection in another plane holding a special relation to the first. These two grand discoveries of modern natural philosophy have compelled mathematicians to recognize, in light, a series of undulations which are propagated in an eminently elastic fluid, named by them, as we know, the ether. And then the retardation which the propagation of light suffices by passing through bodies endowed with the highest refracting powers (well established by divers experiments) gives strong support to this view of the nature of light. But further, from the notion of a repulsive ether, Monsieur Brento has deduced a sublime consequence, and has thus made a comet the parent, or rather the ancestor, of a new proof of the infinity of the created universe.

In the first place, since the light and heat of the stars can only reach us by the agency of the ether, it follows that this fluid must fill the whole of the celestial space in which the stars perform their movements. Secondly, as everything indicates that the movements of the stars in the firmament do not meet with any sensible resistance, it follows that the density of the ether which they traverse must be indefinitely small in comparison with that of the stars; lastly, since the light of the stars evidently reaches us in straight lines, it follows that the density of the ether must be sensibly uniform. But, if the molecules of the ether attracted each other, their dispersion throughout space could not continue uniform. It is true that the exactly uniform dispersion of an attractive fluid would constitute a state of equilibrium; but it would be an unstable equilibrium. That is to say, if disturbed by the slightest local condensation or refraction, the equilibrium would be broken; the fluid would instantly rush in masses to various centers, in virtue of its attractive power, and the uniform dispersion of the fluid would no longer exist. There would ensue, immediately, in some places, partial and local vacuums; and in others, local and limited condensations of the fluid.

On the other hand, a fluid whose particles repelled each other, if distributed in a nearly uniform manner in unlimited space, would tend more and more to a uniform distribution of its particles. Any partial local vacuum would be instantly filled up by the adjoining particles rushing in. In like manner, any partial and local condensation would determine a repulsion by which the too crowded molecules would be driven away from each other, till they met with an equal repulsion from without. Thus, the uniform density of the celestial ether, which remains sensibly the same in spite of the local movements of the heavenly bodies, shows that the atoms of the ether repel each other. And that the energy of the living forces transmitted by the undulations of the ether—the power of the solar light, heat, and chemical action—proves that the repulsion of its constituent atoms is enormous.

Bearing these facts in mind, is it possible to conceive that the ether occupies a finite space in a firmament geometrically infinite in every direction?

If the extent of the ether is limited, it is absolutely necessary that the space it occupies should be enclosed in some vast, continuous distended envelope, capable of offering sufficient resistence to the ether's expansive force, in spite of the enormous radius and span which this sort of roof or vault must have. If, therefore, the ether be limited, we come back to the ancient dream of a solid transparent firmament, made of crystal, or of whatever other substance you please. Be it remembered that this firmament must inclose, not only the sun and its planets, but every star which we behold, and the Milky Way of which they form part, and the nebulæ amongst which our Milky Way is only a single individual, and the congregations of nebulæ, and the congregations of those congregations, and so on to infinity; there being nothing to authorize our limiting the number of the degrees of this stellar hierarchy. Such an idea as that of a crystal wall bounding the universe, can hardly stand a moment's reflection.

We are consequently led to conclude that the celestial ether has no limits whatever; but that it actually extends infinitely in every direction of the geometrical heavens. It now remains to inquire whether, in this etherized immensity, the congregations of stars can, by possibility, be assembled within a limited space, beyond which there exists nothing but the ether only, in all directions, to infinity.

The totality of the stars which exist in the celestial ether, continually transmit to it an enormous quantity of vital force. This force travels through the ether in calorific and luminous undulations, and goes further and further away indefinitely, from the centers of vibration, with nothing to stop it; unless the undulations meet, on their way, with atoms of a nature heterogeneous to the ether, which retain, after the passage of a wave, some fraction of the vital force of that wave. Consequently, if all the ponderable matter of the universe is confined within a given space, all the light and all the heat which makes its escape from this inclosure would be definitely lost to the stellar universe, which would, therefore, cool and grow dark to an indefinite extent; and after a lapse of time, which, though very great, is still finite, an epoch would arrive when the sum of subsistent vital force would fall below any appreciable limit. But if, on the contrary, the ponderable universe is infinite, like the celestial ether, in all directions, the whole of the vital force propagated in the heavens remains always within the circumference of this ponderable universe. In that case, the conservation of action and of vital force becomes separately applicable, on the one hand, to the totality of the celestial ether; and, on the other hand, to the totality of ponderable matter. What is given, and taken, is returned from their opposite quarter, in equal measure; upon the whole, there is no absolute loss or escape of vital force.

Thus, a finite universe swimming in an infinite ether must, little by little, lose its living energies, without the possibility of regaining them; an infinite universe, on the contrary, must preserve its total vital force under any changes whatever in its distribution, such changes being produced partly through the medium of the repulsive ether, and partly by the action of the universal gravitation. The latter of these two hypotheses appears the only one admissable. In fact, all the manifestations of the creative power, which are one in kind, appear *a priori*, to be necessarily inalterable in their sum, provided we conclude in that sum the absolute totality of creation. This law, and that of continuity, are perhaps the two laws which are the most general throughout all creation; and the notion of the indestructibility of matter, now admitted as an axiom, rests upon no other foundation.

An endeavor has, therefore, been made to establish the proposition: First, that the celestial ether (inferred from the retardation of Encke's comet) extends infinitely in all directions, in a firmament geometrically infinite. Secondly, that the ponderable universe is distributed through all the ethereal space, without its being possible that any finite boundary, how vast soever we may conceive it to be, can contain the whole of this ponderable universe.

QUARTZ PRODUCTS.

THE mineral known as quartz (anhydrous silica, SiO_2) found its first technical application a few years ago in the manufacture of tubes for mercury vapor lamps, by the process of Dr. Kuech and the Heraeus Company. This fused quartz, or quartz glass, was obtained from rock crystal, and its cost was consequently very high. The valuable properties of fused quartz, which is not affected by great variations of temperature or by acids, and is a remarkably good insulator, make it very desirable to obtain this material at a moderate cost and in large quantities. Heraeus succeeding in reducing the cost of production of fused rock crystal to some extent, and in placing on the market laboratory vessels of quartz; but the price remained very high until quite recently, when it was found that the expensive rock crystal could be replaced by the very pure quartz sand which is known as glassmaker's sand. Quartz products are already being made in large quantities by the German Quartz Company. The material is used in the production of dishes, flasks, muffles, tubes, beakers, test tubes, crucibles, funnels, mortars, and other implements and vessels used in chemical laboratories. Even cooking vessels, wall plaques, and ornamental vases are made of fused quartz, and the new material will unquestionably soon find a still wider field of industrial application.

According to the German Quartz Company, the sand employed in the manufacture is almost absolutely pure silica, and the quality of the product is greatly injured, although its appearance may possibly be improved by the addition of any other substance. In addition to its resistance to acids (with the exception of fluoric and phosphoric acids), its insentiveness to great and abrupt changes of temperature, and its very high electrical resistance, fused quartz possesses the power of withstanding very high temperatures, so that vessels of this material can be employed for the fusion of metals of very high melting points. Some of the quartz offered by this firm is translucent and has the sheen of mother-of-pearl on its unpolished surface. It can be cut, polished, and worked in the blowpipe flame. Its specific gravity is 2.2; its specific heat, 0.305; its fusing point, about 2,000 deg. C. (3,632 deg. F.). Its expansion by heat is only 0.0005 for 1,000 deg. C., or about one-tenth that of glass. An electromotive force of 35,000 volts is required to force an alternating current of 50 cycles per second through a plate of material ¾ inch thick, and 70,000 volts are required when the thickness is increased to 3 inches.—Prometheus.

THERMAL RADIATIONS OF GREAT WAVE LENGTH.

IT is well known that the visible spectrum comprises only a small part of the entire spectrum known to the physicist. The wave lengths of the luminous rays lie between 0.4 and 0.8 μ. ($1\ \mu = 1/1{,}000$ millimeter or about 1/25,000 inch.) The ultra-violet region of the spectrum, which has been explored chiefly by photographic methods, extends from 0.4 μ to 0.1 μ. In the ultra-red region, the rays of which are detected chiefly by their thermal effects, the extreme lower limit attained until recently was represented by the residual rays reflected by sylvin, which have a wave length of about 61 μ. These rays were obtained by Rubens and Aschkinass by reflecting the radiation of a suitable source repeatedly by means of mirrors of sylvin. In the process the greater part of the radiation is absorbed. The remainder, the so-called residual radiation, is very homogeneous and has the wave length given above. Rubens has recently continued his investigations and has succeeded in obtaining rays of much greater wave length, up to 96.7 μ, or nearly 1/10 millimeter, by means of reflection from potassium iodide. From this point to the extreme ultra-violet the spectrum contains about ten octaves, of which two are in the ultra-violet region, one in the visible section, and seven in the ultra-red. The shortest ether waves obtained by electrical methods have a length of 4.4 millimeters and are therefore several octaves below the rays last mentioned. The known varieties of electro-magnetic waves are given in the following table:

	Wave length.
Waves employed in wireless telegraphy..........	A few meters to several kilometers
Residual rays from potassium-iodide	0.0967 millimeter or 96.7 μ
Residual rays from sylvin............	62.0 μ or 70.3 μ
Beginning of the visible spectrum....	0.8 μ or 800 $\mu\mu$
Red	760 $\mu\mu$
Green	500 $\mu\mu$
End of the visible spectrum..................	400 $\mu\mu$
Ultra-violet rays	400 $\mu\mu$ to 200 $\mu\mu$
Schumann rays obtained in vacuo...	200 $\mu\mu$ to 100 $\mu\mu$

($1\ \mu\mu = 1/1000\ \mu$ or a millionth of a millimeter.)

VISIBLE MOLECULES, CORPUSCLES, AND IONS?

THE NEW THEORY OF MATTER.

WHEN, a hundred years ago, John Dalton gave its modern shape to the atomic theory, which may be traced back to ancient philosophy and to Democritos, nobody expected that scientists would some day isolate, or at least render visible, the single atom and molecule. The kinetic theory of gases ascribed the gas pressure to the bombardment of the walls of the confining envelope by the gas molecules. It taught us how to count and to measure the molecules. But it did not bring the probability of our ever seeing them any nearer; that looked hopeless with 3×10^{19} molecules in a cubic centimeter of a gas, and 640 trillion of atoms in a milligramme of hydrogen. Now that the very foundations of the atomic theory appear to be shaken by the discovery of particles (electrons) one-seventeen-hundredth of the size of the atom of hydrogen and by the phenomena of radio-activity, it is claimed that the visibility of the smallest particles has been demonstrated in various ways. It may be opportune to examine some of the experiments on which such claims are based.

The existence of particles smaller than the atom would not in reality contradict the atomic theory. The atomic theory does not assert that the atom is the smallest particle capable of existence. The name "atom," indeed, suggests something that cannot further be cut or divided. But the essence of the theory is that an elementary substance consists of particles or atoms, all equal to one another and peculiar to that element, and that the single atom is the smallest particle which can enter into combination. The molecule is the combination product of atoms. The atom need not necessarily be the smallest ultimate particle, and many considerations induce modern science to believe that the atom may itself have a constitution. The atoms of different elements differ from one another. Yet the modern scientist feels with the ancient philosopher that there may, after all, be only one kind of matter, which, being grouped in different ways, gives rise to different elements and bodies. There are certainly difficulties in the suggestion that atoms or molecules should be able to split off corpuscles, and remain substantially what they were, while, on the other hand, radium—probably an elementary metal—is to emit radiations which turn into helium—undoubtedly a gas. But those researches are not completed yet, and meanwhile chemists continue to adhere to the atomic theory which has proved so fruitful, and to determine atomic weights with the greatest possible care.

The demonstrations of the possible visibility of molecules are based on observations partly made in less controversial fields. Colloids have furnished the first suggestion of visible molecules or groups of molecules. When mud is stirred up, the particles settle quickly again, and the turbid liquid can, by filtering, be cleared of suspended particles. The particles of an oil emulsion take a long time to settle, and run turbid through the filter. When still finer particles are prepared, for instance, by volatilizing metal electrodes immersed in liquids, the cloudy particles will not settle for many days or months, and finally it may be impossible to decide whether an emulsion or a real solution has resulted. It is quite conceivable that the transition from a suspension to a solution is too gradual to permit of a distinct line of demarkation being drawn, just as the three states of aggregation cannot rigorously be distinguished. Very small suspended particles now are in constant oscillatory movement. These movements were first observed by the botanist Brown in 1827, and are known as Brownian movements. The coarser the particles, the slower and more irregular the movements. For a long time they were ascribed to inequalities of temperature in the turbid liquid. When the ultra-microscope was brought out in Jena, the study of this curiosity assumed a direct scientific interest, and the impression gained ground that the observer really watched molecular movements akin to those which the particles of gases describe according to the kinetic theory of gases. The idea originated, we believe, with Einstein; he certainly worked out the mathematics of the problem. During the past few years J. Perrin, Gouy, Svedberg, and others have supplied apparent experimental proofs for the molecular character of the movements. Perrin counted the number of gamboge granules or particles, in a portion of his colloidal solution, measured their diameters, masses, and paths, and calculated their average kinetic energy. He concluded that the granules had the same average energy of movement as the molecules of the liquid in which they were suspended, and that they behaved thus like molecules of a very high molecular weight.

Now molecules of a high molecular weight—in other words, molecules consisting of a great number of atoms of different elements—are nothing strange to the chemist. Emil Fischer, in his famous researches on the albuminoids, has come to very high molecular weights indeed. In his four series of experiments Perrin dealt with granules whose masses varied as 1 : 3 : 8 : 27. Allowing for the coarseness of his granules and the friction in his medium (water), Perrin deduced for the number N of molecules per cubic centimeter very nearly the same figure, 3×10^{19}, to which other researches have led us. Estimates of this N, we should add, have been made by the most varied and entirely independent methods. Some of the methods give results which, it may be foreseen, should be considered as upper limits, others will yield lower limits. The average accepted value for N was, a few years ago, probably 6×10^{19}; at present scientists incline to half that value, 3×10^{19}.

The experiments of Ehrenhaft confirm those of Perrin. Ehrenhaft votalized silver electrodes in air; the fine-dust granules thus produced exhibited the looked-for Brownian movements, and the free path was longer in air than it had been for granules of the same size in water. Perrin's calculations have, on the other hand, been questioned by Duclaux. But we appear to be justified in assuming that the observer, watching the movements of colloidal particles, sees movements similar to those which we ascribe to the invisible molecules of gases.

Another demonstration of luminous effects, ascribed to single particles, was given by Crookes in London and Regener in Berlin, seven or eight years ago, and thus before the above-mentioned experiments on colloids in which molecules are supposed to be concerned. When the α rays of radium are allowed to fall on a screen or fluorescent zinc sulphide, each particle seems to produce a flash of light like a tiny spark, and brilliant scintillations are observed. Still more instructive is the demonstration of single α particles, which Rutherford and Geiger gave in the Royal Institution two years ago; it was described in our columns at the time. A tube containing radium bromide was held in front of the window of a long tube, several feet away from the window, so that only a few α particles—perhaps not more than one per second—would find their way to the electrometer at the far end of the tube. A sudden jerk of the electrometer indicated that a particle had struck and the number of particles shot out per second were actually counted by counting the jerks. Each α particle is supposed to represent a charged atom of helium, which turns into helium gas on losing its electric charge. Dewar has carefully determined how much helium is produced by a given weight of radium per second, and by putting that figure together with his count of the number of α particles discharged per second, Rutherford arrived at the conclusion that 1 cubic centimeter of helium is formed by 2.56×10^{19} α particles—a most remarkable confirmation of the N.

Another exemplification of the visibility of molecules or, at any rate, of the discontinuity of an apparently homogenous solution, is due to the late Lobry de Bruyn, and has recently been verified by A. Coehn. It refers to the so-called Tyndall effect. A ray of light is, as such, invisible in an optically empty medium. Passed through a glass trough the beam of the lantern is hardly visible, until some turbid medium like smoke is introduced into the trough. The light cone of a lens, concentrated into pure water, leaves the water dark, when it is free of suspended particles, dust, etc. It is, of course, exceedingly difficult to free the water of all dust and floating impurities. Working with the greatest care Lobry de Bruyn succeeded in obtaining pure water, in which the light cone was hardly discernible. But when he dissolved cane sugar in this water, a luminosity was noticed. Coehn has repeated this experiment with the ultra-microscope of Zsigmondy, and the light cone then observed was quite uniform; dust particles or colloids would have shown as bright points. It would, therefore, appear that the large molecules of cane sugar, dispersed through the water, make the water sufficiently discontinuous to reflect the light.

The further endeavors of Coehn to exemplify this discontinuity in solutions in which a transport of the ions and of non-electrolytic particles, drifting with the ions, is produced by electrolysis, will be better understood by a description of some very remarkable experiments of Kossonogow, of Kjew. Kossonogow studies electrolysis with the aid of the ultra-microscope. He bends both the electrodes of his cells twice at right angles, so as to leave a channel, generally 0.2 millimeter in width, between the active surfaces, and coats the other portions of the electrodes with paraffin; the light beam is sent across this channel in which electrolysis takes place. On dissolving various salts, silver nitrate, copper sulphate, ammonium chloride, and others in water, he observed at once—before turning on the current—some luminosity and bright specks in Brownian movements. Some of the specks were no doubt dust particles. But the just-mentioned discontinuity phenomena, and further migration of the ions, were also concerned. For the luminosity increased when the current (of 10 volts, e. g.) was turned on, and the particles were distinctly seen to wander, mostly toward the cathode. If dust granules had alone been at work, the current should gradually have cleared the solution of such granules. But the directed movements were only observed when there was real electrolysis, and no movements and hardly any luminosity were seen when the solvent was not water, but a non-electrolyte, like benzol. The bright specks were, moreover, deflected from their rectilinear paths when the cell was placed in a strong magnetic field. On reversing the current, the bright specks also reversed their movements, which took place at the rates of migrating ions, and on applying alternating currents the particles seemed to be undecided which way to move.

All these observations appear to indicate that the moving particles are either ions, or other bodies or molecules, drifting together with the ions, and it has long ago been pointed out that the migrating ion would carry some of the solvent with it. The following observations of Kossonogow are of particular interest. When a certain critical potential was applied, the number of bright specks suddenly increased very much, and they crowded near the cathode, but a dark space, from 0.05 to 0.08 millimeter in width, was always left close to the cathode. This dark cathode space—so well known from experiments on the electric discharge through gases—was very well defined, and it was particularly striking when cathodes were used which were not plain, but curved in fanciful ways. The boundary of the dark space always kept parallel to the contours of the cathode. Beyond the dark space the bright particles were in lively motion; but no bright particles crossed the dark space, though the ions must traverse it to be deposited on the cathode. It looked, Kossonogow says, as if the ions lost their luminosity, together with their electric charge, when passing the dark space. When the critical potential—1 volt for silver nitrate in water—was exceeded, another crowding of the bright spots to a bright band was noticed intermediate between the electrodes. The crowding of the bright points and the dark space were also seen in copper sulphate. When silver electrodes were dipped into a colloidal solution of silver in water, the phenomenon changed. The bright spots crowded near the anode, not near the cathode, but there was no dark space separating them from the anode.

Whatever one may think of the interpretation of these phenomena, it will be conceded that the decomposition products of electrolysis are concerned in them. Whether the bright spots seen are really the ions, whether the optical discontinuity is really due to single molecules, whether the scintillations and electrometer discharges are indeed produced by single α rays—i. e., single charged helium atoms—and whether the colloidal granules represent real analogues of molecules, whether, in brief, the phenomena, which we have reviewed, really constitute effects of ultimate particles—these questions remain open, of course. Chemists decline to follow physicists into some of their novel theories. But problems present themselves which were unknown to the exact science of past generations, though such questions entered into their speculations, and the perfection, especially of electrical and optical methods and instruments, of research certainly has provided us with means of conducting investigations which the past generations could hardly hope to attain.—Engineering.

The Aero Club Committee of France have submitted the first proposed rules of the air to the French Minister of Public Works. Airships and aeroplanes are to fly at not less than 150 feet clear of buildings and inclosed property, and they must not stop above such property at any height less than 1,500 feet. Aerial craft must pass to the right, and dirigibles are to have the right of way over aeroplanes. Special permission must be obtained to fly over towns and cities. Aviators must be examined and licensed, and license numbers must be displayed upon the machines. All buildings over 150 feet in height must be lighted at night time, and the names of villages must be painted in large letters on the roofs of railway stations.

ELECTRICAL NOTES.

Quite recently the large wireless station at Nauen, near Berlin, has maintained communication with a steamer of the Woermann Line during the whole of its journey from Hamburg to West Africa, and to continue to exchange messages with it after it had come to anchor at the Cameroons. From there to Nauen the wireless distance is roughly 4,000 miles, and the waves had to negotiate such obstacles as the Alps, the Algerian tableland, and the mountains of Adamana. This is by far the best over-sea and land record yet made.

The Electrical World gives particulars of the experimental trials now being carried out by the United States Navy Department with a view to ensuring wireless communication over great distances. It is intended to erect a "master" station at Washington, with an an iron mast 600 feet high, and transmitting apparatus of 50-kilowatt capacity. Other naval stations will be equipped with 25-kilowatt apparatus, and battleships and first-class cruisers will have 10-kilowatt installations, all of high frequency and capable of communicating over a distance of 1,000 miles not only by night, but also by day—a much more difficult feat. The makers of the Fessenden apparatus have secured the contract, and are carrying out trials to meet the specified conditions, with the aid of naval vessels equipped with the Fessenden system.

The advocates of the continuous-current system as against the single-phase system for electric railways have just had their claims supported in a forcible manner. The Washington, Baltimore and Annapolis Railway was changed over from single-phase to 1,200-volt continuous current on February 15th. The reason for the change was that the company desired to run into Washington city, but was prevented owing to the weight of its cars. An investigation followed, which promised large savings in first cost and operating expenses. The change was, therefore, decided on, and the results are said to have fully substantiated the findings of the commission. It is stated that the saving in electric energy amounted to 25 per cent even during the first few days, when the drivers were new to the equipments.

The Virginia Railway and Power Company, Richmond, Va., formerly used for its armature and axle bearings a tin base metal, which proved unsatisfactory, as the bearings broke frequently before the metal was worn away to any considerable extent. The old metal ran from 12,000 miles to 26,000 miles in the armature bearings, and 11,000 miles to 19,000 miles in the axle bearings. It has now been replaced by a bronze bearing composed of 77 per cent copper, 15 per cent lead, and 8 per cent tin. Some of these new bearings have already given over 50,000 miles and are still in service. All armature bearings are bored with a self-centering machine and afterward rolled under pressure, which gives a remarkably smooth finish, and thereby tends to increase the life of the bearing since, at the start, there are no inequalities in the surface.

Various methods have been employed for the purpose of protecting electric light and power wires from accidental currents of high potential and high frequency. The oldest method consists in inserting between the line and the earth, in parallel with the self-induction coil, a condenser of small capacity, which allows the accidental current of high frequency to pass, without involving appreciable loss of the working current. Effective protection is given, also, by the Giles valve, which is composed of a fusible plug, a spark gap, a resistance and a lightning arrester with numerous gaps, formed of disks of zinc, insulated from each other. The high frequency current escapes to earth through all of these instruments, which are connected in series, but the escape of the working current is prevented by the spark gap. A third device consists of a series of electrolytic valves, which serve both to increase the capacity and to limit the tension. They are usually connected in series with lightning arresters of the horn type.

ENGINEERING NOTES.

We hear that the Swiss State Railway authorities are engaged in securing water power all over the country for the purpose of electric-power supply for the railways. The power secured in Canton Tessin now amounts to 30,000 horse-power, and in Canton Uri to 17,000 horse-power. The total amount already taken is about 70,000 horse-power, and still more is required.

The Krupp Works at Essen in Germany are constantly increasing in size. The number of men employed by the company at its work in Essen and elsewhere increased during 1909 by nearly 4,000, so that at the end of 1909 about 67,000 men were in the employ of the company. At the Essen works a total horse-power of over 73,000 is used, this power operating over 7,000 separate machine tools, over 900 cranes, 187 trip hammers, and 81 hydraulic presses.

The bottoms of many Swedish lakes are covered to a thickness of six or eight inches with fragments of iron ore of the size of peas. This lake ore consists chiefly of ochre or hydrated oxide of iron, mixed with silicate and phosphate of iron, clay, sand and other impurities, and yields pig iron of very good quality. The ore is obtained by very primitive methods. In winter a hole is cut in the ice, a scraper attached to a long pole is inserted, and all the ore within reach is collected into a heap beneath the hole. Some of the mud which has been scraped together with the ore is removed by stirring the mass with poles, and the ore is then scraped into bags which have been sunk, and is hauled up. In summer this curious mining operation is conducted in a similar manner from rafts anchored in the lake. Two miners can bring up about four tons of ore in a day. Steam dredges have recently been installed in a few places. About thirty years after the removal of the ore, a new layer of the same thickness is found to have been produced by natural chemical processes.

A concrete jacket for a leaky concrete chimney has recently been put into use. The chimney in question is 80 feet high and cylindrical for a greater part of its height, with an inside diameter of 4 feet and a wall thickness of 4 inches. It was built about five years ago out of dry, porous concrete, and for some time past has given trouble owing to the cracks and holes affecting the draught. It was decided to jacket the whole outside with a 5-inch thickness of concrete reinforced with 32 vertical rods hooped with circumferential rods at 6-inch centers. For the work a form was built of sheet iron made up of three equal segmental parts and 5 feet in height. The three parts were joined together by bolts through vertical angles on the edges of the segmental plates. To the forms a working platform was built, and the whole contrivance hung by tackle from the top of the chimney and pulled up as concreting progressed. A wrapping of asbestos felt was put around the old chimney to form an expansion joint between the old and new concrete, and also to prevent the heat from the chimney drying out too rapidly the newly laid concrete. First 5 feet of asbestos wrapping was placed, then the reinforcing steel, then the form was pulled up over the section and the concrete deposited. The next morning the process was repeated, so that concreting was always done in the afternoon and the forms removed from it the following morning.

SCIENCE NOTES.

The ordinary form of liquid bath for the determination of melting points has been modified by the introduction of an air-bubble system, causing a rapid circulation of the liquid, and hence a uniform temperature. The same idea has been very ingeniously applied by Mr. H. Stoltzenberg—Zeitschrift für physikalische Chemie, March 11th—in designing a low-temperature cooling bath. The liquid—pentane—is caused to circulate by means of hydrogen bubbles through a spiral dipped in liquid air, ether and solid carbon dioxide or a mixture of ice and salt, according to the temperature required, and then passes into the vacuum-jacketed vessel in which the measurements are carried out. The temperatures can be easily regulated by altering the amount of the spiral immersed, and can be kept very constant.

The longitudinal pressure of a train of sound waves coming from a vibrating tuning fork may be readily shown as a lecture room experiment. A torsion balance is made by a suspension of silk or quartz, the beam being of fine glass tube 10 centimeters long with a thin piece of mica 2 or 3 centimeters square at one end balanced by soft wax at the other. A mirror in the middle serves to show the deflection. The whole is mounted in a box with tube for the suspension. One side of the box should have a glass window and another covered with loosely stretched rubber dam through which a short heavy brass rod projects, its cross section being equal to the size of the mica vane to which its end is parallel at the distance of 1 or 2 centimeters. The stem of the vibrating fork is applied to the outer end of the brass rod, which then receives longitudinal vibrations, gives them to the air in the box, and so affects the vane. A König fork of 256 per second gave a deflection of 6 feet to 10 feet on a wall 20 feet distant. The spot of light does not move for 2 or 3 seconds.

Lehmann's attempts to produce artificial coloration in liquid crystals have proved that these crystals, like solid crystals, are incapable of absorbing foreign matter in a state of uniform molecular distribution. Lehmann has also observed that combined or mixed crystals are formed very frequently by heteromorphous, but very rarely isomorphous substances. In a recent article, Lehmann expresses the opinion that foreign molecules imprisoned in a crystal are arranged according to the crystalline system, by the operation of the same directive forces that govern the arrangement of the molecules of the crystal itself, and that any other distribution of such foreign molecules is impossible. This theory accounts for the production of dictroism. A crystal growing in a viscous mass or colloidal suspension eliminates the suspended particles. This progressive elimination is very striking in the crystallization produced by cooling a hot saturated solution of para-azoxyanisol in mono-bromo-naphthalene, containing in suspension the minute globular spores of *Lycoperdon*. An incomparably finer suspension is furnished by a commercial dye which is composed of triturated lampblack combined with fat or soap. When a hot saturated solution of this dye is allowed to cool, the fine particles of lampblack are eliminated, and fill the interstices between the fat crystals, which appear as perfectly transparent drops on a black background. In view of the impossibility of maintaining colloids in uniform or irregular suspension in crystalline liquid, Lehmann believes that such liquids, like solid crystals, possess a power of spontaneous purification, and can be purified by repeated (liquid) crystallization. In almost all of the few cases in which Lehmann succeeded in coloring liquid crystals, the regular arrangement of the foreign molecules was indicated by the appearance of dichroism. This power of spontaneous purification may be employed as a criterion to distinguish crystalline from amorphous liquids. A colloidal solution is necessarily amorphous.

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